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NAME OF AUTHOR/*NOM DE L'AUTEUR* Andrew KLAR

TITLE OF THESIS/*TITRE DE LA THÈSE* A PHYTOGEOGRAPHICAL STUDY OF SOUTHESTERN ALBERTA

UNIVERSITY/*UNIVERSITÉ* University of Alberta

DEGREE FOR WHICH THESIS WAS PRESENTED/*GRADE POUR LEQUEL CETTE THÈSE FUT PRÉSENTÉE* Master of Science

YEAR THIS DEGREE CONFERRED/*ANNÉE D'OBTENTION DE CE GRADE* 1979

NAME OF SUPERVISOR/*NOM DU DIRECTEUR DE THÈSE* Dr. J. G. Packer

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THE UNIVERSITY OF ALBERTA

A PHYTOGEOGRAPHICAL STUDY OF SOUTHEASTERN ALBERTA

by

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A THESIS
SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH
IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE
OF MASTER OF SCIENCE

DEPARTMENT OF BOTANY

EDMONTON, ALBERTA
FALL, 1979

THE UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled

A Phytogeographical Study of Southeastern Alberta

submitted by Andrew Klar in partial fulfilment of the requirements for the degree of

Master of Science in Botany

John G. Packer ....
Supervisor

Charles Schweger ....

....

Dale H. Vitt ....

Date.. June 22 1979 ....

ABSTRACT

The study area included the main vegetational zones of east central and southeastern Alberta, the aspen parkland, mixed prairie and the Cypress Hills. Approximately 2400 specimens of vascular plants were collected from 51 numbered sites and additional roadside locations. The following habitats and associations in the area are described: _Populus_ transitional forest; _Sphagnum_ bogs; sandhills; _Populus_ groves; _Festuca scabrella_ grassland; meadows; shores of lakes and rivers; floating and emergent aquatics from shallow waters; mixed prairie; dry coulees; eroded banks and saline sloughs.

The following specimens are reported for the first time for the study area: _Equisetum variegatum_ Schleich., _Lemna trisulca_ L., _Poa juncifolia_ Scribn., _Nuphar variegatum_ Engelm., Caltha natans Pall., _Viola palustris_ L. and _Pedicularis groenlandica_ Retz. Several species which are rare or uncommon in the study area were also collected.

The total number of species and the percentage breakdown are listed for the following phytogeographic categories within the study area: widespread species, aspen parkland species, western aspen parkland species, prairie species, southern prairie species, southeastern prairie and Cypress Hills species. Restricted occurrences and overlapping ranges were also noted.

The North American and global geographical affinities of the study area taxa are shown as total numbers, percentages and species lists for the following categories: I. Circumpolar species (17%); II. Widespread boreal and temperate North American species (15%); III. Northern species (3.3%); IV. South-temperate North American species (4.6%); V. Eastern American species (3%); VI. Western American species (19%); VII. Southern or Great Plains species (17%); VIII. Southwestern species (15%) and IX. Cordilleran species (5.6%).

The distribution patterns show a large number of widespread species with no discernible phytogeographical affinities. The species with restricted ranges show overwhelmingly western affinities.

The postglacial revegetation of the study area occurred in late glacial and early postglacial times. The direction of plant migrations was from south to north with no evidence indicating migrations from the the Alaska-Yukon survivium. The widespread species were probably the early colonizers of the study area. Their distribution patterns were not as useful for the elucidation of postglacial migration patterns as were fossil pollen records and the presence of disjunct populations in the Cypress Hills.

ACKNOWLEDGEMENTS

I would like to express my appreciation to my supervisor, Dr. J. G. Packer, for suggesting the research topic, verifing the identity of the collected specimens and making available the distribution maps of the vascular plants of Alberta compiled under his direction. The field work was supported by the National Research Council grant No. A2582 to Dr. J. G. Packer.

I would also like to thank the other members of the examining committee, Drs. K.E. Denford, D.H. Vitt and C.E. Schweger, for reading the manuscript and making valuable suggestions, and Dr. P.R. Gorham, chairman of the Department of Botany, for his encouragements and administrative help. Discussions with Drs. Schweger and Vitt were especially stimulating and I am grateful for the effort and time they spent on the thesis. The generous assistance from the staff of the Computing Services of the University of Alberta greatly facilitated data processing and text production.

Madelaine Dumais introduced me to the methods of field work, herbarium use and plant identification. Shannon Campbell proofread and edited successive drafts of the manuscript. For their careful work and kind encouragement I am deeply grateful. My thanks also to Grace Stewart for proofreading the final draft of the thesis, to Maxine Hancock for helping

to organize and reorient the direction of my writing, and to Les and Gisela Klar for their kind hospitality during my stay in Edmonton.

I would also like to express my gratitude to Lakeland College for providing educational leave and working facilities. I am especially grateful to Roger Laurin, chairman of the Life Sciences Division at Lakeland College, for his patience and generous support throughout the project.

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INTRODUCTION

The aims of this study are to describe the flora of east central and southeastern Alberta, to add to the existing distribution records and to trace the plant migration routes into the study area. When contrasted with the extensive collections from mountainous regions, the parkland and the prairie have received relatively little attention from botanists. The lack of variation in topography and soils may have contributed to a preception of the region as uninteresting. The distribution patterns of plants occuring in the study area were not fully described. A question was apparent: Were the gaps in the collection records indicative of discontinuities in plant distributions or were they merely the result of incomplete collections? On the basis of distribution maps the study area was examined for recurring patterns which defined phytogeographic regions or districts in an attempt to answer the following questions:

(1) What are the geographic affinities of the flora?

(2) What were the directions of the late glacial and postglacial plant migrations into the study area?

(3) Can the course of these migrations be traced by examining the distribution pattern of different species in the North American continent?

(4) Does interpretation of plant distribution patterns agree with interpretation derived from fossil pollen profiles when applied to the late glacial and postglacial history of the flora?

(5) Could other sources of information be applied to the problem?

The floristic history of eastern Alberta cannot be separated from the history of the North American continent. The events considered here are regional migrations in response to epochal changes in the continental and global climates. The paucity of Pleistocene fossil records discovered within the study area makes it all the more necessary to consider data from adjacent areas.

THE STUDY AREA

The study area is located in east central and southeastern Alberta between the 49°00' N and 53°30' N latitudes and the 110°00' and 112°30' W longitudes, encompassing the aspen parkland and prairie of eastern Alberta.

The area is bounded by the Saskatchewan border to the east, the United States border to the south, the boreal forest to the north (roughly coinciding with the North Saskatchewan River), and by a line along the 112°30' W longitude then along Highway 4 to the west and southwest. Although the parkland and prairie extend beyond the western boundary of the study area, the precipitation is higher and the vegetation is markedly richer in boreal and montane species west of latitude 112°30' W than east of this line. National Topographical Series 1:250,000 scale map sheets which cover the area are listed in Table 1.

Table 1.

NATIONAL TOPOGRAPHIC SERIES MAP SHEETS

Vermilion	73E	Edmonton	83H (East half)
Wainwright	73D	Red Deer	83A (East half)
Oyen	72L	Drumheller	82P (East half)
Medicine Hat	72L	Gleichen	82I (East half)
Foremost	72E		

A map of the study area and its vegetational zones are shown in Figure 1. The collecting sites are listed in Table 2 and illustrated in Figure 2.

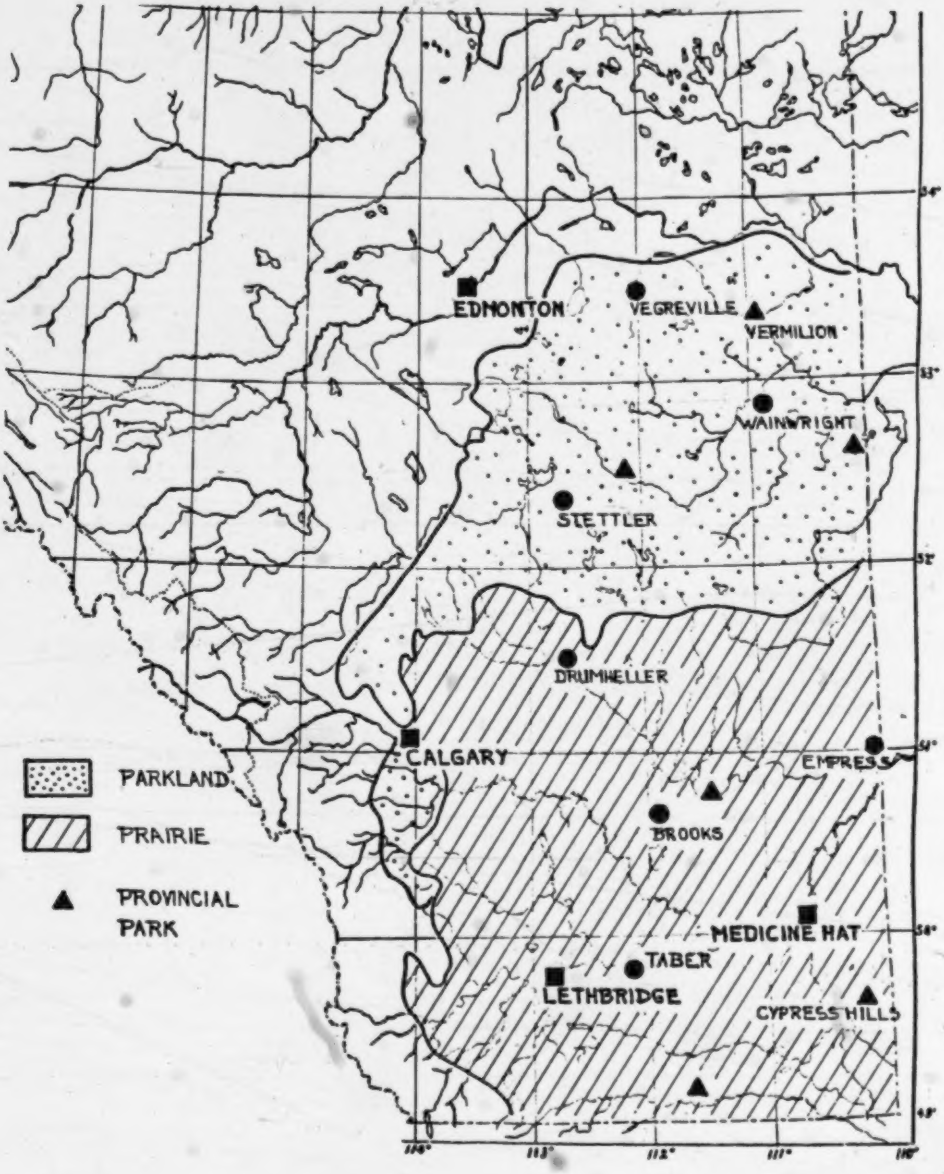
EDMONTON
VEGREVILLE
VERMILION
WAINWRIGHT
STETTLER
DRUMHELLER
CALGARY
EMPRESS
BROOKS
MEDICINE HAT
TABER
LETHBRIDGE
CYPRESS HILLS
PARKLAND
PRAIRIE
PROVINCIAL PARK
54°
53°
52°
51°
50°
49°
114°
113°
112°
111°
110°

Figure 1. Boundaries of the major vegetational zones of Alberta. The hatched area represent prairie grassland, the stippled part is aspen parkland and the unmarked area is mainly boreal forest. The boreal-montane forest of the Cypress Hills is not shown. After Moss (1932).

Table 2.

COLLECTING SITES

(Roadside collections of less than 3 specimens not included)

Code	Location	Latit.	Longit.	No. of specimens
1	Pinehurst Lake	54°39'N	111°28'W	18
2	Ironwood Lake	54°36'N	111°32'W	8
3	Ashmont	54°24'N	111°37'W	12
4	Bonnyville	54°12'N	110°45'W	20
5	Gardner Lake	54°11'N	111°43'W	5
6	Elk Point	53°55'N	110°50'W	15
7	Laurier Lake	53°50'N	110°34'W	105
8	Tulliby Lake	53°45'N	110°11'W	31
9	Two Hills	53°40'N	111°05'W	15
10	Lea Park	53°39'N	110°22'W	45
11	Clandonald	53°35'N	110°45'W	10
12	Vermilion	53°22'N	110°53'W	40
13	Birch Lake	53°19'N	111°29'W	19
14	Isley	53°18'N	110°33'W	41
15	Kinsella	53°03'N	111°32'W	115
16	HW 41 x Battle River	53°00'N	110°52'W	51
17	Wainwright	52°45'N	110°49'W	95
18	Edgerton	52°45'N	110°28'W	31
19	Alliance	52°40'N	111°05'W	20
20	Dillberry Lake	52°35'N	110°01'W	131
21	Big Knife	52°29'N	112°11'W	78
22	Battle R. x HW 36	52°25'N	111°49'W	10
23	Halkirk	52°23'N	112°00'W	41
24	Horseshoe Lake	52°21'N	110°44'W	119
25	Stettler	52°20'N	112°55'W	25
26	Provost	52°11'N	110°26'W	38
27	Nose Hills	52°10'N	111°10'W	7
28	Neutral Hills	52°10'N	110°51'W	18
29	Monitor	51°58'N	110°55'W	10
30	Altario	51°49'N	110°11'W	71
31	Hand Hills	51°23'N	112°12'W	72
32	Oyen	51°23'N	110°28'W	8
33	Acadia Valley	51°15'N	110°13'W	17
34	Empress	50°57'N	110°01'W	48
35	Dinosaur	50°45'N	111°34'W	75
36	S. Sask. Riv. x HW 41	50°44'N	110°05'W	25
37	Schuler	50°22'N	110°18'W	19
38	Chappice Lake	50°09'N	110°21'W	11
39	Walsh	50°07'N	110°04'W	29
40	Seven Persons	49°52'N	110°53'W	107
41	N of Elkwater	49°41'N	110°17'W	3
42	Chin Coulee	49°34'N	111°52'W	18

43	Conrad	49°31'N 112°00'W	21
44	Grant Creek	49°28'N 110°05'W	29
45	Orion	49°25'N 110°50'W	52
46	Pendant d'Oreille	49°12'N 110°53'W	25
47	Writing-on-Stone	49°07'N 111°39'W	115
48	Onefour	49°06'N 110°36'W	78
49	Pinhorn Graz. Res.	49°05'N 110°55'W	24
50	Aden	49°04'N 111°17'W	27
51	Wildhorse	49°01'N 110°15'W	32

Physiography and drainage.

The parkland in the northern part of the study area is undulating to rolling, while the prairie in the south varies from undulating to nearly flat. The area lies within the Alberta Plain which, in turn, forms part of the Southern Interior Platform (Bostock 1970). Elevation of the plains is approximately 700 metres near the North Saskatchewan River, rising to nearly 1000 metres at the United States border. The Neutral Hills form a chain of prominent hills rising to about 120 metres above the surrounding plains (Bayrock 1967). The Hand Hills rise some 200 metres and the broad plateau of the Cypress Hills to nearly 500 metres above the surrounding terrain. Lacustrine plains of recent origin have almost no relief and the outwash and glacio-lacustrine deposits are also relatively flat surfaced (Bayrock 1967).

The surface runoff water is collected by four main drainage systems: the North Saskatchewan, Red Deer, South Saskatchewan and the Milk River basins (Green and Laycock

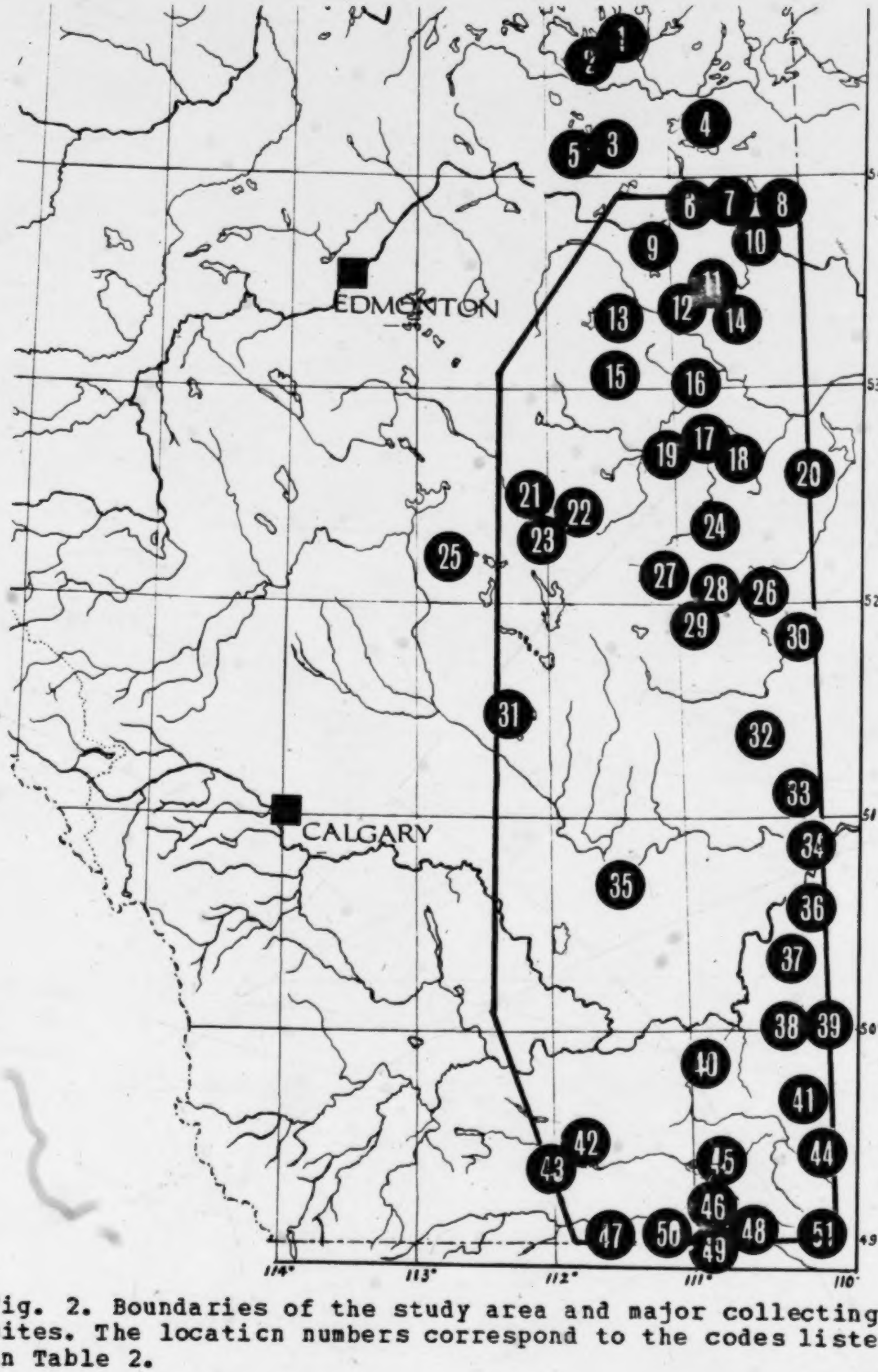
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Fig. 2. Boundaries of the study area and major collecting sites. The location numbers correspond to the codes listed in Table 2.

1967). The northern part of the aspen parkland drains into the North Saskatchewan River, while the southern parkland is drained by the Red Deer River system. Most of the prairie streams flow into the South Saskatchewan. The extreme southern part of the study area drains into the Milk River which, together with several creeks, flows into the Missouri River (Westgate 1968). Several parts of the study area drain internally into saline ponds. The largest of these are the Pakowki Lake (Westgate 1968) and Many Island Lake internal drainage systems (pers. obs.). The creeks and rivers are of postglacial origin and flow in steeply sided valleys. The dry and intermittent channels or "coulees" are often covered with thick vegetation including shrubs and trees.

Most of the parkland is characterized by knob-and-kettle topography (Ellwood 1961; Bayrock 1967). The depressions are often filled with water and are surrounded with rings of _Salix_ and _Populus_ species.

Bedrock geology

The study area lies in the geologic region of the Western Canadian Sedimentary Basin. The precambrian basement is an average of 1200 m below the surface, gently sloping towards the southwest (Bostock 1970).

The bedrocks which lie immediately below the unconsolidated glacial deposits are all Upper Cretaceous in age, with the exception of the Tertiary conglomerate of the Cypress Hills (Westgate 1968, Allan 1944). Four major geological formations underlie extensive areas in the region. The marine deposits of the Belly River Formation occupy most of the eastern part of the study area. Laid down from non-marine brackish water, the formation is composed of bentonitic sandstones and clays (Allan 1944). In the Red Deer River valley the eroded Belly River strata form the famous badlands.

The Edmonton Formation lies closest to the surface in the western part of the region, overlying the Bearpaw Formation. The latter is found in the western and central part of the study area. It consists of dark marine shales with some bentonite and salt (Bowser et al. 1962). The marine deposits of the Bearpaw and Belly River Formations have contributed to the salt content of the soils and sloughs of east-central and southeastern Alberta. The Cypress Hills conglomerate is a hardened alluvial deposit of Oligocene age. It is about 15 m thick in the western part of the Hills, increasing to about 150 m in the east and is made up of pebbles and gravel with some silt and clay (Westgate 1968). The Neutral Hills and the Hand Hills are prominent ridges characterized by contorted bedrock formed when the bedrock, which lies immediately under the thin glacial mantle, was squeezed up by the weight of the glaciers (Bayrock 1967).

Surface geology

Overlying the bedrock there is a layer of unconsolidated glacial drift, varying in thickness from a few centimetres to 30 metres, originating from both the Canadian Shield and local bedrock. The glacial deposits are classified according to relief, mode of deposition and composition. The description below is based on reports by Bayrock (1961), Ellwood (1961), Westgate (1968) and the following geological maps:

Foremost-Cypress Hills	72E (Westgate 1968)
Galahad District	72D in part (Bayrock 1958)
Medicine Hat	72L (Berg and McPherson 1971)
Wainwright	73D (Bayrock 1967)
Vermilion	73E (Ellwood 1961)

Ground moraines occupy the largest area. They form a "blanket of drift, which is deposited by direct glacial action, has low relief, and has no curvi-linear trend ..." (Ellwood 1961). Ground moraine forms gently undulating till deposits with reliefs averaging about two metres and thickness of about six metres. Till is a non-sorted sediment laid down by moving ice. It is made of particles ranging from less than clay size to boulders. The mineral composition of the till reflects the type of bedrock over which the glacier passed. The large erratic boulders of granitic and gneissic composition, for example, are derived from the Canadian Shield.

Hummocky moraines have a local relief exceeding five metres and thickness of usually over 18 metres. Characterized by knob-and-kettle topography, they were formed when glacial debris partially buried detached blocks of the wasting icesheet. Some of the basal debris was carried into englacial or superglacial position along the thrust planes within the ice. Varying thicknesses of the mantle of debris brought about differential melting. When the buried iceblocks finally melted, the till above them collapsed, leaving depressions which are now often filled with water, at least during part of the year (Clayton 1967). Patches of lacustrine sand, silt and clay are commonly found on hummocky moraines. They are thought to have been accumulated in shallow ponds on the surface of stagnant ice and let down, together with the superglacial till when the ice melted (Westgate 1968). The ponds on the glaciers formed when eskers or iceblocks dammed up meltwater on the wasting ice surface. Superglacial Lake Wildhorse in the extreme southeastern corner of Alberta resulted from such deposits. Surface features formed by glaciers outside of the ice margin are called proglacial landforms. Outwash plains or aprons are quite common in central Alberta (Bayrock 1967). In the Foremost-Cypress Hills area where the regional slope was towards the glacier margin, meltwater ponded against the ice and formed proglacial lakes (Westgate 1968). Meltwater channels which conducted water away from the glaciers are quite common throughout the area. They form steep-sided coulees which may be as wide as two km or as narrow as 100 m. Some meltwater channels form the streambed of present day rivers such as the Milk River (Westgate 1968).

Endmoraines form a series of aligned ridges parallel to the former icefront. Other landforms deposited directly by the glaciers are linear disintegration ridges and crevasse fillings. Some of the modified till deposits are drumlins, flutings and kames which are all quite common in Alberta.

Aeolian deposits are usually in the form of parabolic sand dunes and blowouts. Such deposits are found in the Wainwright-Provost area, on the east side of Pakowki Lake, southeast of Taber and in the Middle Sand Hills north of Medicine Hat (Bayrock 1967; Westgate 1968). All of the dune areas are now stabilized by vegetation with the exception of some blowout spots. Although the exact time of their deposition is not known, the dunes are considered to be of Holocene age and may have been formed during the mid-Holocene Hypsithermal (Westgate 1968) when the warmer and drier climate may have caused the vegetative cover of lacustrine alluvial sand deposits to die off or at least become too sparse to protect the soil from wind erosion. Aeolian deposits of Pleistocene age form the thin loess deposits of the Cypress Hills. The loess consists of unconsolidated sand, silt and clay, and it is generally less than 1.5 m thick (Westgate 1968).

Climate.

The climate of the Alberta plains is typically continental with warm summers, cold winters and low precipitation. Geography has a major influence on the climatic pattern here. The Cordillera in the west forms a barrier which deflects most of the low level westerly winds towards the north. There are only a few mountain passes which allow the penetration of the Pacific air currents (Bryson and Hare 1974). Along its main path near the 45th and 50th latitudes, the low level westerly flow is the strongest forming an air wedge over the prairies. The largest volume of westerly air currents enters western Canada at an altitude above the mountains. When it descends on the east slope of the Rocky Mountains its temperature increases and its humidity decreases. Cold air masses entering from the arctic sweep southward without impediment (Bryson and Hare 1974). They stay near the surface and may cross the entire length of North America in a few days' time without losing their arctic character. Tropical air currents may, on occasion, reach southern Canada on the ground but usually they are forced aloft by the colder arctic and pacific air masses.

The climatic regions defined by the annual sequence of airstream dominance correspond well with most of the major biotic regions (Bryson and Hare 1974). The regions dominated by arctic airstreams for 10 to 12 months of the year are characterized by tundra. The ones covered by it for 3 to 9 months are largely boreal forest. The plains occupied by dry pacific air in winter for more than 6 months are designated as "steppe" by Bryson and Hare (1974), and the area under the influence of the moist tropical airstream during the summer forms the prairie of the Central Great Plains.

According to the Koeppen system of classification, the study area falls in category D, that is microthermal with the average temperature of the warmest month above 10°C and the coldest month below -3°C (Longley 1972). The Aspen parkland or "moist steppe" and the prairie or "dry steppe" are in subcategory Db, having warm summers. The cool summers of the Cypress Hills place it in subcategory Dc (Longley 1972). Past climates of the areas are described briefly under the History of the Flora.

The amount of moisture available limits plant growth to a varying degree throughout the study area. Mean precipitation values are shown in Fig. 3 and also in Table 3, along with the absolute maximum and minimum temperatures. Such data however does not give a complete picture of the climatic conditions as they affect plant survival and growth. Laycock (cit. by Longley 1972) calculated the average moisture deficit by taking the difference between the potential evapotranspiration and the precipitation falling during the growing season plus 10 cm soil moisture reserve. The average moisture deficit varies from over 25 cm in the prairie to 15

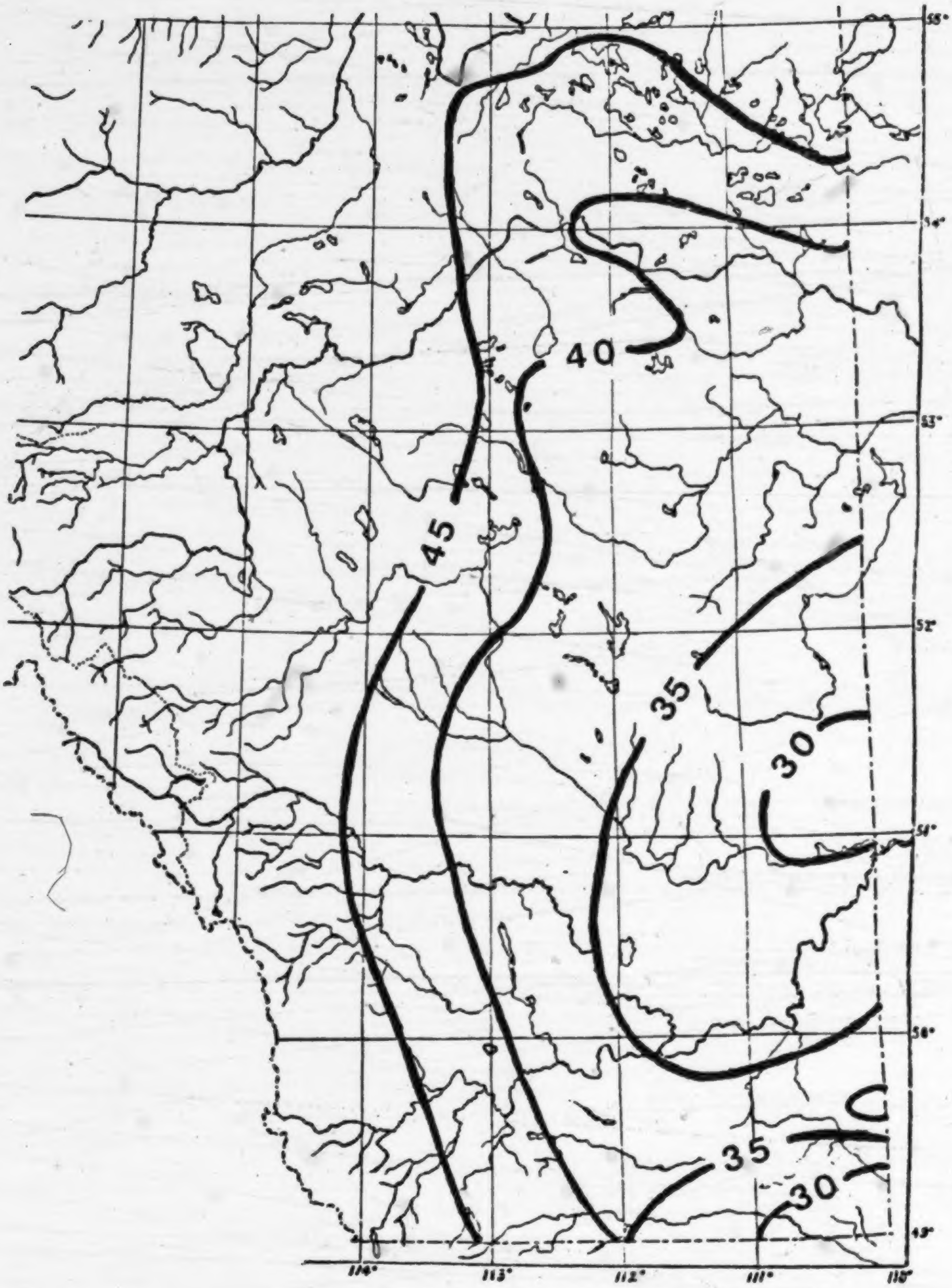

45
40
35
30
35
30
55°
54°
53°
52°
51°
50°
49°
114°
113°
112°
111°
110°

Fig. 3. Mean yearly precipitation in the study area in cm. After Longley (1972).

to 24 cm in the aspen parkland. Evaporation from a free water surface does not, however, necessarily correspond to evaporation from soil surface or plant cover and, moisture deficit calculated on the basis of potential evapotranspiration does not necessarily indicate drought. Studies by Walter (1973) have shown that the temperature curve approximates the evapotranspiration curve. When the temperature curve is superimposed on the precipitation curve, moisture surplus or deficit can be graphically illustrated. If the temperature curve at a scale of 10° C=1 cm surpasses the precipitation curve shown at a scale of 20 mm=1 cm, severe drought is indicated. Light drought is indicated by the temperature curve surpassing the precipitation curve on the 30 mm scale. Figure 4 shows that Manyberries and Empress, two prairie locations, regularly suffer from drought during July and August, while Vermilion and Marwayne in the northern part of the aspen parkland are not so affected.

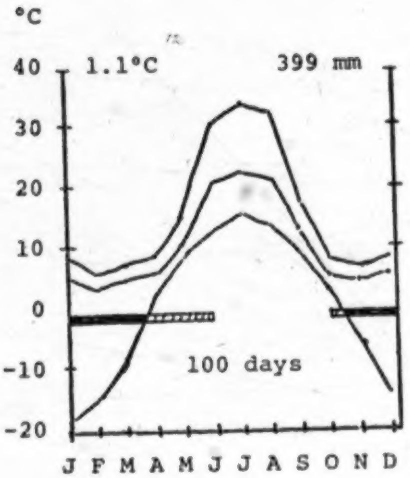
Table 3.

PRECIPITATION AND TEMPERATURES 1941-1970

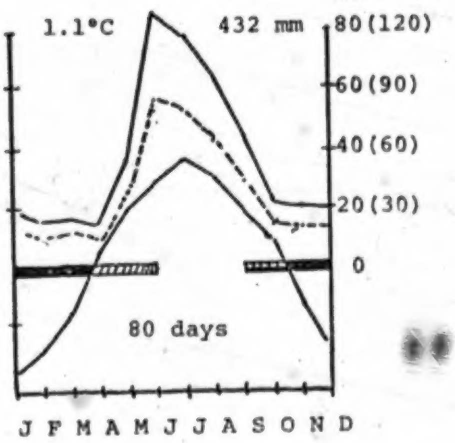
Location	Mean precipitation cm	Absolute maximum temp.°C	Absolute minimum temp.°C
Elk Point	42	39	-53
Vegreville	42	35	-51
Vermilion	40	37	-49
Empress	22	42	-47
Hanna	37	39	-45
Brooks	36	40	-45
Medicine Hat	35	42	-46
Taber	37	40	-42
Manyberries	32	40	-42
Milk River	30	41	-40
Cypress Hills	46	N/A	N/A

(Alberta Environment 1976)

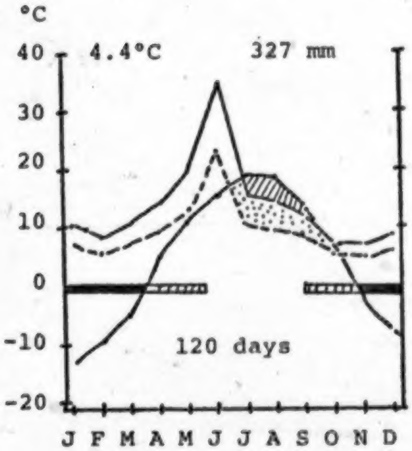
Figure 4. Climatic diagrams showing the interrelation of temperature and precipitation. After Walter (1973). Months of the year are plotted on the horizontal axis, temperature on the left vertical axis, precipitation on the right vertical axis at the 20 mm scale and 30 mm scale (in brackets). Mean annual temperatures and precipitation for the period 1941-1973 are shown in the upper left and right corners respectively. Lowest curve indicates mean monthly temperature, the middle and upper curves are monthly precipitation plotted on the 30 mm and 20 mm scale respectively. Frost free days (minimum temperature >°C). Solid bar is months with mean temperature <0°C. Diagonally hatched bar is months with absolute minimum temperature <0 °C.



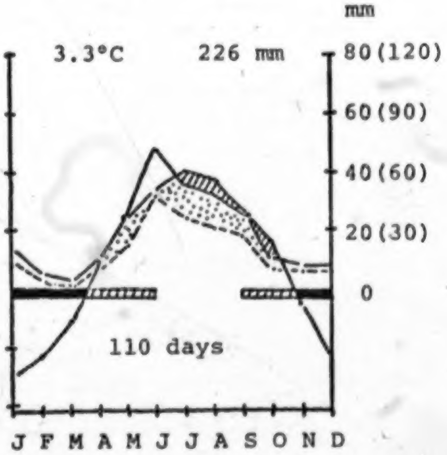
Vermilion Lat. 53°22'



Marwayne Lat. 53°30'



Manyberries Lat. 49°06'



Empress Lat. 50°57'

Soils

The soils of central and southeastern Alberta reflect the influence of the soil parent material, drainage and the climatic and vegetational history of the area (Leahey 1965). Soil development began immediately after the receding of the glaciers and the exposure of the deposited debris. Oxidation altered the minerals, especially the iron compounds. Water and carbonic acid leached most of the calcium carbonate to an average depth of 50 cm (Nat. Soil Surv. Comm. 1970), and aided in the translocation of clays, iron and aluminum compounds to the 20 cm level. The leaf litter from the early postglacial forest probably accelerated leaching, although this is not apparent in modern soil profiles. With the establishment of prairie plants further changes took place. The cyclic growth of grasses favored the accumulation of organic matter in the form of high molecular weight humus compounds which resisted further decomposition in the arid and cool climate of southeastern Alberta. Under tree vegetation, on the other hand, acidic decomposition products from leaves accelerated the eluviation of clays, iron, aluminum and calcium compounds from the uppermost mineral horizons of the soil.

As a result of the removal of certain materials and the accumulation of others, distinct horizons developed in the uppermost part of the parent material (Leahey 1965). Mineral soil horizons which make up the soil profile are designated by the letters A, B, C and their various subscripts. They can be differentiated by their color, texture, structure and chemical composition. The horizons collectively make up the soil profile. The A horizon is a zone of eluviation from which clays, iron and aluminum compounds and calcium carbonate have been removed (Nat. Soil Surv. Comm. 1970). Organic matter may accumulate in this horizon. Materials removed from the A horizon accumulate in the B horizon. An exception to this is calcium carbonate which is carried to the uppermost portion of the C horizon. The latter is the parent material of the soil which has been little changed except for the accumulation of calcium and magnesium compounds and some oxidation.

The semi-arid to subhumid climate of Alberta's parkland and prairie favored a predominantly grassland vegetation and, under good drainage, the development of Chernozemic soils. Chernozems are well to imperfectly drained mineral soils having high base saturation of predominantly calcium ions (Nat. Soil Surv. Comm. 1970). They are found in cool, semiarid to subhumid continental climates and developed from relatively non-saline parent material. High molecular weight decomposition products from the roots of xero- and mesophytic herbaceous plants accumulated as humus, imparting a dark coloration to the surface layer or Ah horizon. According to the National Soil Survey Committee (1970) criteria, chernozemic Ah horizons should contain more than 1.5% organic matter in the top 15 cm and the aggregates or peds should be well flocculated to resist disintegration. The B horizon is typically a textural Bt enriched with clay and iron, showing a blocky structure. The parent material is designated as the C horizon. Its top portion is enriched in calcium and magnesium carbonates and is therefore designated as Ck.

Chernozemic soils belonging to the Black Great Group (see Fig. 4.) have Ah horizons with Munsell color values darker than 3.5 moist or dry. The chroma should be 1.5 or less when the top 15 cm of the soil is mixed and is in moist condition. These soils developed under Festuca-Agropyron grassland and are the best farming soils in Alberta. Brown chernozems have Ah horizons with Munsell color values darker than 3.5 moist or 5.5 dry, and chromas greater than 1.5 dry. These soils developed under mixed grass prairie vegetation. Plant growth here is limited mainly by the amount of moisture.

Sodium and magnesium salts may be transported into the soil profile by ground water. The accumulating salts may cause solonetzic conditions with a hard Bnt horizon and may appear on the surface as white crusting (Bowser 1965). The ground water discharge and deflocculated clay layers make water penetration very slow. The poor growing conditions often cause characteristically patchy plant growth.

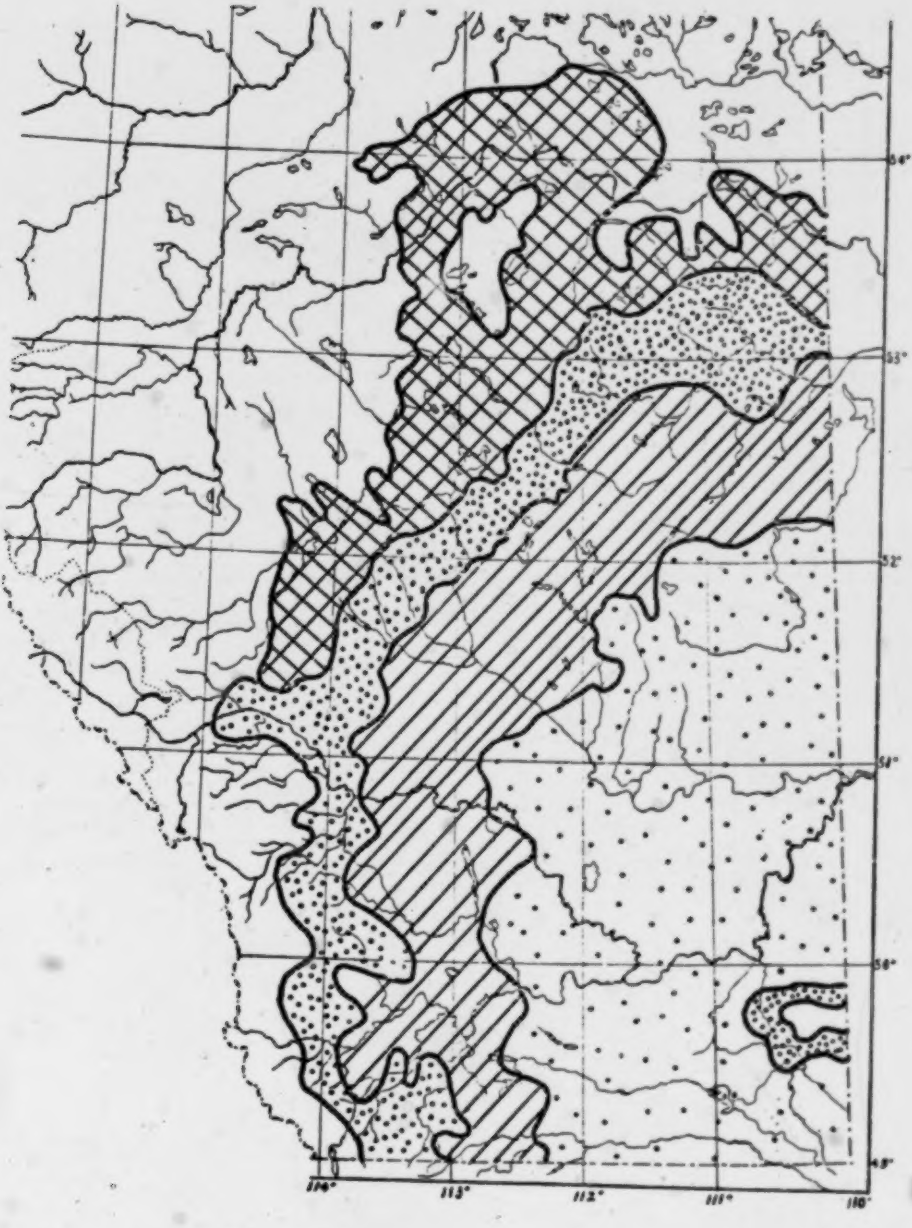


Figure 5. Soil zones of Alberta after Odynski (1962). Light stippling indicates the brown soil zone; diagonal hatching is dark brown zone; heavy stippling is thin black and crosshatching shows the black soil zone. Unmarked areas are mainly gray wooded soils. The above zones are now considered informal as they do not correspond to the official terminology of the National Soil Survey Committee (1972), nevertheless they are useful for illustrating soil-climate-vegetation interrelationships.

HUMAN INFLUENCES

The time of the original entry of man into North America has not yet been ascertained. His entry through the Bering strait was, in all probability, a slow migration in search of new hunting territory. Findings of projectiles and other artifacts in the United States and Mexico dated between 14,000 and 30,000 years B.P. indicate that prehistoric man entered central North America well before the final retreat of the Wisconsin glaciers, possibly through an ice-free north-south corridor (Quigg and Kidd, Provincial Museum of Alberta 1978, pers. comm.).

Evidence from animal kill sites with weapon remains indicate that nomadic hunters pursuing the bison camped at the edge of the retreating glaciers as early as 11,000 years ago (Bryan 1967). Man is thought to have been the major cause of a "sudden wave of large-animal extinction" during the late Pleistocene. Martin (1967) and others (Edwards 1967; Jelinek 1967) suggested that at the end of the last glaciation at least thirty two genera disappeared in North America, mostly large terrestrial herbivores, their predators and scavengers. These animals survived the severe stresses of Pleistocene glaciations, and there appears no other reason for their extinction but a rapidly spreading human population dependent on animal sources for food. Although direct evidence of human association with many of the extinct genera is lacking (Jelinek 1967), the chronology, the selection of large herbivores and the absence of unfavorable environmental conditions suggest that, "through his omnivorous habits and through his capacity for rapid cultural evolution, man exterminated many species" (Edwards 1967). Of the large herbivores only the bison remained in significant numbers to influence the growth and composition of the vegetation in central North America.

The plains bison was killed off by the 1870's and other animals, including the elk, plains grizzly, wolf, kit fox and the prairie chicken were also greatly reduced in numbers (Johnston 1970). By 1880 the Canadian prairie was virtually devoid of grazing animals and the unusually high precipitation from 1880 to 1885 resulted in relatively luxuriant growth not seen before or after (Johnston 1970).

Even in prehistoric times human activities influenced the vegetation of central and southern Alberta. The Plains Indians regularly set fire to the grass and brushland to control vegetation and game. Bird and Bird (1967) quote from the 1798 diary of the explorer, David Thompson, as follows: "Along the Great Plains there are many places where ... Aspens have been burnt ... and no further production of trees have taken place, the grasses of the plains are constantly increasing in length and breadth and the Deer give way to the Bison".

Another explorer, Henry Youle Hind, wrote in 1858 (cit. by Nelson 1973) that "From beyond the South Branch of the Saskatchewan to the Red River all the prairies were burnt last autumn, a vast conflagration extended for one thousand miles in length and several hundreds in breadth ...".

After the arrival of the white man, the native tribes occasionally used fire for short term economic advantages. According to the traders (Nelson 1973), in the 1780's and 1790's the Indians burned the grass to drive the bison and other game animals away from the trading posts and the white hunters. The Indians then offered meat to the traders at very much inflated prices. In the late 1800's fire was also used in preventing the depleted bison herds from crossing into the United States.

Ranching began about 1885 and farming about 20 years later. Both have had a profound effect on the flora and vegetation of our area. Cultivation has removed much of the native cover and livestock grazing has altered nearly all of the remaining original vegetation (Smoliak 1965). Although the grasslands of the Great Plains have supported large grazing animals as, for example, the bison since prehistoric times, ranching reduced the movement of the animals and caused overgrazing in some localities. Overgrazing resulted in the decrease of some palatable species including *Agropyron smithii*, *A. dasystachium*, *Eurotia lanata* and *Stipa spartea* var. *curtiseta*. At the same time the less palatable *Artemisia cana*, *A. frigida*, *Koeleria cristata*, *Bouteloua gracilis*, *Selaginella densa* and *Opuntia polyacantha* increased. Weedy species, both native and introduced, including *Bromus tectorum*, *Grindelia squarrosa* and *Tragopogon dubius* invaded the denuded areas of rangelands (Smoliak 1965 and pers. obs.). Farms in the parkland flourished but the southern prairie proved too arid for small scale dry land farming. By 1924 the settlers of southern Alberta were moving into the new irrigated areas and to homesteads in the black and grey wooded soil zones. Prairie fires stopped with the arrival of ranchers and farmers in the 1890's (Johnston 1970). Grazing and cultivation became the main influences on the native vegetation.

Cultivation necessarily destroys much of the native plant cover, increases the chances of erosion and makes it possible for weeds to get established. Table 4 shows that 42% of the prairie in the study area is under cultivation in the forms of crops, summerfallow or cultivated pasture while in the aspen parkland the proportion of cultivated acreage is 68%. Except for the steepest slopes, all woodland is used for livestock grazing, as evidenced by the presence of fences, cattle droppings, hoofmarks, animal trails and human refuse. According to my observations, truly natural areas which have not been influenced by man or domestic animals are virtually non-existent but unbroken and lightly grazed areas approach what must have been the original state of the vegetation. Human traffic and agricultural imports brought the propagula of weedy plant introductions as, for example, Cirsium arvense, Euphorbia esula, Taraxacum officinale and Salsola kali (Frankton 1961; Alberta Agriculture 1976; Schofield 1969).

Irrigation and certain cropping practices have contributed to an increase in the salinity of the topsoil. Assessment records show (McCracken 1973) that in the county of Lethbridge farmland affected by salinity has increased nearly tenfold between 1960 and 1970, from 1.8% to 16% of the cultivated acreage. This increase is due to dryland seepage following the reduction of vegetative cover. Plants have the effect of removing surplus water from the soil while extensive summerfallowing contributes to the raising of the water table and the discharge of saline water. Irrigation has favorably affected some soils in southern Alberta by markedly decreasing the sodium salt content of the profile (Milne and Sadler 1963), but soils belonging to the Solonetzic order have suffered. In the latter, due to high exchangeable sodium and low permeability of the subsoil, irrigation water tended to build up the salt content near the surface.

The effects of various construction projects on the

TABLE 4.

LAND USE IN THE ASPEN PARKLAND AND PRAIRIE OF EASTERN ALBERTA

Areas in hectares.

Total area	Crops	Summer fallow	Pasture	Wood land	Other including range
Prairie 5,432,090	1,284,189	734,883	212,492	6,265	3,153,842
	24%	14%	4%	0.1%	58%
Aspen parkland 3,732,608	1,666,683	633,376	221,984	81,689	1,152,655
	45%	17%	6%	2.2%	31%
Total 9,164,698	2,950,872	1,368,259	434,476	87,954	4,206,497

Statistics Canada (1978) The 1976 Census Report for divisions 1, 2, 4, 7 and 10.

vegetation are evident throughout the area. The local drainage has often been blocked or altered by road construction, creating new aquatic environments in roadside ditches. Borrow pits and dugouts for water storage created new pools of water which are being colonized by plants.

PREVIOUS STUDIES

Eugene Bourgeau accompanied the Palliser expedition and worked in Alberta from July, 1858 till May, 1859. He was the first botanist to examine the prairie south of the North Saskatchewan River (Wallace 1928). John Macoun (1922) took his first journey across the prairies in 1872 and returned several times to scout the country for botanical specimens, a route for the transcontinental railway and the possibilities for agriculture. The collections made during these journeys formed an important part of his Catalogue of Canadian plants (Macoun 1902).

Cormack investigated the forest ecology of the Cypress Hills in 1945 (Breitung 1954) and made a study of the orchids there (Cormack 1948). Breitung (1954) made a thorough survey of the vascular plants of the Cypress Hills and listed 664 taxa, 241 of which were collected on the Alberta side. De Vries and Bird (1968) later supplemented this catalogue by listing 83 taxa for the Alberta side of the Cypress Hills which Breitung recorded only for the Saskatchewan side, and 26 taxa which were new to the Hills. Breitung and de Vries as well as Bird enumerated and discussed the presence of taxa which belong to the Cordilleran element.

Ezra Moss, in the course of his studies of the vegetation of

Alberta, made extensive collections in the southeastern part of the Province. He summarized his findings in his review, The vegetation of Alberta (Moss 1955), and in the Flora of Alberta (Moss 1959). Robert Coupland (1950, 1952) studied the grassland communities of the western Canadian prairie and redefined their classification.

Silvester Smoliak and Alexander Johnston have conducted long term studies of the vegetation and range ecology of southern Alberta (Smoliak et. al. 1975; Mitchell and Smoliak 1971). Their collections have been deposited in the herbarium of the Canada Department of Agriculture Lethbridge Research Station (Smoliak and Johnston 1978). Johnston (1970, 1977) also investigated the historical aspects of the southern Alberta grasslands.

Charles D. Bird (1962) studied the bryophytes of the Cypress Hills. In his annotated catalogue for the aspen parkland Bird (1969) listed 154 bryophyte taxa consisting of 15 hepatics, 2 Sphagna and 137 Musci. His catalogue of lichens (Bird 1972) included 669 taxa (542 species) for Alberta, Saskatchewan and Manitoba. Bird's (1973) catalogue of bryophytes for the same area listed 648 taxa (599 species).

Bernard de Vries made a preliminary investigation of the botany of the Writing-on-Stone Provincial Park and collected 202 species of vascular plants. As noted above, he contributed, with C. D. Bird, 109 taxa to the vascular flora of the Cypress Hills (de Vries and Bird 1968).

Cliff Wallis (1975) collected in the Milk River region of southern Alberta and prepared an inventory of the area. He described the plant and animal communities and listed 41 species of lichens, 13 species of bryophytes and 357 species of vascular plants.

Dennis Jaques (1977) conducted an in-depth investigation of the vegetation and range ecology of the Suffield Military Reserve, north of Medicine Hat. He documented the change in biomass and floristic composition due to grazing, and listed 304 species of vascular plants for the Reserve.
Bernard Boivin (1967) and other workers of the Canada Department of Agriculture and the National Museum of Canada collected extensively in the study area.

DESCRIPTION OF VEGETATION

Transitional forest

The main vegetational regions of the study area are the aspen parkland, mixed prairie and the boreal-montane forest of the Cypress Hills (seeFig. 1). In preparation for defining the boundaries of the study area, peripheral collections were made in the transitional forest and in the southern part of the boreal forest. The sites examined in the boreal forest included 1 Pinehurst, 2 Ironwood and 4 Gardner Lakes as well as 3 Ashmont, situated between 100 to 200 km northeast of Edmonton (see Fig. 2). This region, with its abundant aquatic sites, is aptly named Lakeland. Although not included in the study area for phytogeographic purposes, these sites in the boreal forest are examined for comparison with related vegetation in the aspen parkland and the Cypress Hills. The vegetation, dominated by continuous forests of *Populus tremuloides* with *P. balsamifera* in moist sites, is similar in composition to the "mini forests" of *Populus* groves in the parkalands of central Alberta. Moss (1955) regarded the "entire poplar vegetation of central and northern Alberta .... as an association, within which aspen and balsam poplar consociations are recognized". Nevertheless the boreal and transitional *Populus* forest differs in composition from the groves of the aspen parkland. Some of the characteristic plants found there but not in the aspen parkland and south are *Vaccinium* *caespitosum*, *Mertensia paniculata*, *Cypripedium passerinum* and such marsh and shoreline species such the *Acorus calamus*, *Calla palustris*, *Caltha natans*, *C. Palustris*, *Impatiens capensis* and *Cicuta bulbosa*.

Sphagnum bogs, present in the boreal and transitional forests just north of the study area but characteristically absent from the aspen parkland and south of it are characterized by an undulating carpet of various *Sphagnum* species. Growing in and on the *Sphagnum* are species tolerant of the cool, wet and acidic environment characterized by such species as *Rubus chamemorus*, *Oxycoccus microcarpus*, *Vaccinium vitis-idea var. minus*, *Cladina rangiferina*, *Menyanthes trifoliata*, *Potentilla palustris*, *Caltha palustris*, *Ledum groenlandicum*, *Larix laricina*, *Picea mariana*. In eastern Alberta Sphagnum bogs do not occur south of the North Saskatchewan River and marshes become dominated by *Typha* sp. and species of *Carex*, *Scirpus*, *Juncus*, *Glyceria*, and *Calamagrostis*.

Just north of the study area boundary, the no. 7 Laurier - Whitney lakes collecting site is covered mainly by outwash sand moved around by wind. In the depressions *Sphagnum* bogs are prevelant containing species described above and also *Betula glandulosa*, *B. papyrifera* and *Salix sp*. depending on the moisture conditions. The upland sandhill sites form the southernmost locality for *Pinus banksiana* in eastern

Alberta. The crown cover varies from open savanna type to closed canopy forest. The mid-shrub layer is characteristically very sparse or absent. The ground cover consists of a carpet of *Cladina rangiferina* interspersed with *Arctostaphylos uva-ursi* and *Vaccinium myrtilloides*, species which are absent from sand dune areas in the aspen parkland and prairie. Habitats with loam or sandy loam deposits support *Picea glauca* growing near its southern limit.

Collection sites 4 Bonnyville, 6 Elk Point, 8 Tulliby Lake, 9 Two Hills and 10 Lea Park, are situated in the transitional aspen forest with understory characterized by *Spiranthes romanzoffiana*, *Maianthemum trifolia*, *Actaea rubra*, *Polygala senega*, *Mertensia paniculata*, *Mitella nuda*, *Cypripedium calceolus* var. *pubescens*, *Habenaria obtusata*, *Monesis uniflora* and *Ribes triste*, species not common in the *Populus* bluffs of the aspen parkland. The site at Myrnam is located at the southern limit of *Picea glauca* in eastern Alberta (see also Zoltai 1975).

Aspen parkland

In the parkland, aspen groves are interspersed with prairie (see Fig. 1 for vegetational zones). Bird (1969) regarded it as an "ecotone, or area of stress, where two major vegetational formations come together and intermingle". Moss (1955) spoke of "true tension lines or ecotones ...

occurring where aspen and prairie communities meet". Bird and Bird (1967) noted that the aspen parkland, as an extensive vegetational zone, is unique to Canada's prairie provinces, and that the "western bastion" of the parkland is in east-central Alberta. Moss (1955) discussed the possible origins of the aspen parkland and remarked that the groves of *Populus tremuloides* must have been initiated by seed but, at the present, the trees spread by suckering.

Some of the early explorers, including Palliser and the geologist Dawson (Moss 1955), thought the groves of *Populus* were remnants of forests devastated by fires, but now the importance of the "master hand of climate" is recognized (Moss 1955; Ritchie 1976; Bryson et al. 1968), although fires also played a role (Bird and Bird 1967). The forest and aspen parkland contracted during dry periods and expanded when the climate became cooler and more moist.

Northern parkland

Bird (1969) regarded this part of the aspen parkland as a subclimax of the forest formation. The composition of the aspen bluffs is similar to that of the boreal forest, except for some species as outlined above. The substantial understory consists mainly of *Amelanchier alnifolia*, *Cornus stolonifera*, *Viburnum edule*, *Ribes oxyacanthoides*, *Symphoricarpos albus*, *Prunus pensylvanica*. The herbaceous species found in the aspen bluffs commonly occur in the boreal forest as well, indicating a close relationship between the two floristic regions. Collection sites 12 Vermilion, 14 Isley, 16 Battle River, 17 Wainwright, 20 Dilberry Lake, 15 Kinsella, 13 Birch Lake and 45 Two Hills represent the northern part of the aspen parkland. The two components of the parkland are the aspen bluffs and the fescue grassland. The aspen bluffs are small forests restricted to moist depressions and north-facing slopes. The landform is predominantly hummocky disintegrational moraine with knob and kettle topography providing a variety of moist and dry habitats. At the latitude of Two Hills the aspen tends to spread over the upland sites and level terrain, restricted by cultivation as well as moisture conditions.

The large openings in the aspen parkland were, before the turn of this century, occupied by luxurious grassland dominated by *Festuca scabrella*. Practically all of the fescue grasslands have now been cultivated or heavily grazed by livestock. The small areas which remain are restricted, mostly to provincial parks. In addition to *Festuca scabrella*, Agropyron subsecundum, Danthonia intermedia, Stipa spartea var. *curtiseta*, *Geum triflorum*, *Heuchera richardsonii*, *Aster falcatus* and *Sysirinchium montanum* are common in the association. In the clearings *Symphoricarpos occidentalis* may form extensive patches on medium textured soils and *Eleagnus commutata* occupies sandy areas.

Bird (1969) described the bryophyte flora of the aspen parkland of west-central Canada, listing 154 taxa, consisting of 15 hepatics, 2 Sphagna and 137 Musci. The most common bryophyte of the *Populus* groves is *Pylaisiella polyantha*. Other common mosses found there are *Brachythecium salebrosum*, *Eurhynchium pulchellum*. *Ceratodon purpureus* is frequently found on disturbed soils throughout the area, while *Funaria hygrometrica* is characteristic of moist, exposed sites. *Plagiomnium cuspidatum* is common in moist depressions in *Populus* forests.

Site 14 at Isley is approximately 18 km east of Vermilion and was chosen for its sizable block of lightly grazed fescue grassland alternating with patches of *Symphoricarpos occidentalis*, *Amelanchier alnifolia* and *Populus tremuloides*. The hummocky moraine landform with rolling topography provides some diversity of habitats. The grassland is dominated by *Festuca scabrella*. Other grasses commonly occurring in this association are *Agropyron subsecundum*, *A. dasystachyum*, *Helictotrichon hookeri*, *Stipa viridula*. The herbs are represented by *Lilium philadelphicum*, *Heuchera richardsonii*, *Potentilla hippiana*, *Solidago missouriensis* and *S. rigida*. In the depressions *Calamagrostis canadensis*, *C. inexpansa* and *Poa palustris* are abundant. On the south facing slopes the vegetation is more xerophytic in character, as exemplified by *Bouteloua gracilis*, *Koeleria cristata*, *Stipa spartea* var. *curtiseta*, *Orthocarpus luteus*, *Grindelia squarrosa*, *Gutierrezia sarothrae*, *Haplopappus spinulosus*, *Allium textile*, *Chrysopsis villosa* and *Helianthus laetiflorus*. These species are typical of the prairies, yet several of them occur at northern latitudes occupying the drier and warmer southern exposures.

Site 16 at the crossing of the Battle River and Highway 41 has dry habitats on a south facing slope as well as small sloughs and aspen bluff on moist habitat. On the south facing slope we find the same xerophytic species as in site 10 with the addition of *Psoralea argophylla*, *Astragalus drummondii* and *Linum lewisii*. The aquatic and semiaquatic species found in the small slough at the base of the slope include *Beckmannia syzigachne*, *Calamagrostis inexpansa*, *Deschampsia caespitosa*, *Glyceria borealis*, *G. grandis*, *Glaux maritima*, *Puccinellia nuttalliana*, *Myriophyllum exalbescens*, *Juncus balticus* and *Scirpus validus*. A noteworthy collection was the finding of *Ledum groenlandicum* in a moist depression at the edge of an aspen bluff. Except for the Cypress Hills, this has been the southernmost collection of this species.

Site 17 is a sand dune area between 10 and 20 km southeast of Wainwright with sparse *Festuca scabrella* - *Agropyron subsecundum* grassland alternating with *Populus tremuloides* bluffs on north facing slopes and depressions. There are a number of small lakes in the area with sandy shorelines as well as some saline sloughs. Some of the species typical of the sandy habitats are *Juniperus horizontalis*, *Calamovilfa longifolia*, *Elymus canadensis*, *Erysimum asperum*, *Astragalus tenellus*, *Astragalus missouriensis*, *Petalostemon purpureum*. *Spirea alba* dominates an extensive low lying area and some sandy slopes are occupied by *Eleagnus commutata*, *Asclepias ovalifolia* and *Apocynum androsaemifolium*.

Outwash and aeolian sand deposits have formed unique habitats which have escaped cultivation. Small pockets of *Populus tremuloides* occur in the depressions even in areas far beyond its normal range.

An extensive aspen bluff facing the shore of Arm Lake, situated on fertile and moist soil, includes species typical of the boreal and transitional aspen forests, such as *Betula papyrifera*, *Actaea rubra*, *Agrimonia striata*, *Lathyrus ochroleucus*, *L. venosus*, *Polygala senega*, *Viola rugulosa*, *Aralia nudicaulis*, *Pyrola asarifolia*, *P. elliptica*, *P. secunda*, *Lysimachia ciliata*, *L. thyrsifolia*, *Bromus anomalus* and *Castilleja miniata*. The shallow waters of Arm Lake contains *Nuphar variegatum* and *Caltha natans*, uncommon in the study area. On the moist shoreline *Houstonia longifolia*, *Tofieldia glutinosa* and *Veronica americana* were collected.

Site no. 13, Dillberry Lake area, is covered with a variety of vegetation including sand dune, aspen forest meadow and lakeshore communities. Dillberry Lake is located in the middle parkland, on the Alberta-Saskatchewan border. The sand dune vegetation here differs markedly from that of the Laurier-Whitney lakes site 120 km to the north. *Pinus banksiana*, *Picea glauca*, *Cladina rangiferina*, *Vaccinium myrtilloides* and *Betula papyrifera*, present on sandy areas at Laurier Lake, were absent at Wainwright and Dillberry Lake. The wet depressional areas were also quite different with species of *Carex*, *Scirpus*, *Juncus*, *Triglochin* and *Petasites* dominating instead of the *Sphagnum* and *Picea*. On the sandy sites *Rumex venosus* and *Rhus radicans* were collected at Dillberry Lake but not at locations north of here. Several species common to most sandy sites were collected in this area. These included *Juniperus horizontalis*, *Elymus canadensis*, *Hierochloe odorata*, *Sporobolus cryptandrus*, *Erysimum asperum*, *E. cheiranthoides*, *Spirea alba*, *Oenothera biennis*, *Asclepias ovalifolia* and *Chrysopsis villosa*.

The forested vegetation was similar to other treed areas of the aspen parkland. Under *Populus tremuloides* groves *Equisetum arvense*, *Actaea rubra*, *Lathyrus venosus*, *Viola rugulosa*, *Pyrola asarifolia*, *Lysimachia ciliata*, *Hackelia americana* and *Linnaea borealis* were collected.

Southern parkland

Location 24 covers an area near Horseshoe, Cap Ayre and Gooseberry Lakes southeast of Provost near the southern boundary of the aspen parkland. Surface deposits with undulating to rolling topography are hummocky moraine, kame moraine, outwash sands and sand dunes. Flat to depressional areas are of lacustrine origin (Bayrock 1967). There are several saline sloughs and lakes in the area, including Horseshoe and Gooseberry Lakes, which provide internal drainage for surface runoff and shallow groundwater flow (Wallick 1979). The lakeshore vegetation, which is often surrounded by salt crust, forms rings and patchworks of *Agrostis scabra*, *Distichlis stricta*, *Salicornia rubra*, *Juncus balticus*, *Suaeda depressa* and *Triglochin maritima*. A band of *Hordeum jubatum* may occur on the moist shoreline. These species were often growing through the salt crust but fresh water seepage of less than 1 mmho per cm was discharged into the lake diluting the salt brine at root level (pers. obs.). *Spartina gracilis* occurred in the transitional zones between fresh water discharge and salt crust areas, while *Muhlenbergia asperifolia*, *Puccinellia nuttalliana*, *Scirpus americanus*, *Carex sp.*, *Lycopus americanus* and *Glaux maritima* were collected at fresh water discharge points.

The upland sites are covered by mixed grass vegetation, and clumps of *Eleagnus commutata* and *Symphoricarpos occidentalis*. Bluffs of *Populus tremuloides* were frequent on north facing slopes. The mixed grass vegetation consisted mainly of *Agropyron spicatum*, *A. subsecundum*, *Bouteloua* *gracilis*, *Festuca scabrella*, *Helictotrichon hookeri*, *Koeleria cristata*, *Stipa spartea* var. *curtiseta*, *S. viridula*, *Allium textile*, *Geum triflorum*, *Gaura coccinea*, *Cerastium arvense*, *Comandra pallida* and *Heuchera richardsonii*.

On sandy sites *Equisetum scirpoides*, *Juniperus horizontalis*, *Arctostaphylos uva-ursi*, *Calamovilfa longifolia* and the occasional *Rhus radicans* and *Rumex venosus*.

The non-saline meadows were occupied mainly by *Deschampsia caespitosa*, *Carex viridula*, *Scirpus nevadensis*, *S. americanus*, *Lilium philadelphicum*, *Zygadenus elegans*, *Spiranthes romanzoffiana*, *Habenaria hyperborea*, *Betula occidentalis*, *Parnassia palustris*, *Cicuta douglasii*, *Lycopus americanus*, *Viola palustris*, *Pedicularis groenlandica*, *Lobelia kalmii*, *Liatris ligulistylis*, *Aster hesperius* and *Solidago graminifolia*.

Some of the eroded slopes showed evidence of saline discharge and the vegetation there was very sparse. Some of the typical species on the eroded dry saline seeps were *Gutierezzia sarothrae*, *Opuntia fragilis* and *Grindelia squarrosa*.

The *Populus tremuloides* groves contained an understory which included species usually found in the transitional and boreal forests, as exemplified by *Pyrola asarifolia*, *Thalictrum venulosum*, *Smilacina stellata*, *Disporum trachycarpum*, *Geum allepicum*, *Poa secunda*, *Shepherdia canadensis*, *Bromus anomalus*, *Lathyrus ochroleucus* and *Actaea rubra*. Near the edge of *Populus* groves *Prunus pensylvanica* and *Amelanchier alnifolia* were found.

Site 15 is located in and around the Kinsella Ranch of the University of Alberta on rolling to hilly topography of hummocky moraine deposits. Kinsella is situated in the central part of the aspen parkland. The *Festuca scabrella* dominated grassland is intermixed with *Populus tremuloides* groves. The latter are found mainly on north facing slopes and in low lying areas. In addition to *Festuca scabrella*, some of the grassland species are *Helictotrichon hookeri*, *Muhlenbergia cuspidata*, *Stipa viridula*, *Agropyron subsecundum*, *Koeleria cristata*, *Danthonia intermedia*, *Bouteloua gracilis*, *Cerastium arvense*, *Gaura coccinea*, *Sphaeralcea coccinea*, *Penstemon gracilis*, *Gaillardia aristata*, *Heuchera richardsonii*, *Potentilla gracilis*, *Astragalus agrestis*, *A. drummondii*, *Hedysarum alpinum*, *Psoralea argophyla*, *Thermopsis rhombifolia*, *Vicia sparsifolia*, *Orthocarpus luteus*, *Penstemon gracilis*, *P. procerus*, *Monarda fistulosa*, *Agoseris glauca*, *Solidago missouriensis* and *S. rigida*.

The understory vegetation of *Populus tremuloides* groves is similar to that of other groves in the aspen parkland. *Lathyrus ochroleucus*, *L. venosus*, *Thalictrum venulosum*, *Viola rugulosa* and *Rubus strigosus* are among the species which were found here.

In a small meadow, six km north of Kinsella, *Viola nephrophila*, *Dodecatheon radicatum*, *Primula incana* and *Senecio pauperculus*, species uncommon in the area were collected along with *Glyceria striata*, *Triglochin maritima*, *Eriophorum angustifolium*, *Ranunculus cymbalaria*, *R. sceleratus*, *Zizia aptera*, *Salix candida* and *Salix brachycarpa*.

Location 13 at Birch Lake is an example of an area which did not prove to be a significant because of the lack of varied habitats and the extent of agricultural activities. The lakeshore *Populus* and *Salix* is heavily grazed by livestock and the rest of the area is under cultivation. For these reasons only a few specimens were collected here.

Western parkland

The western part of the aspen parkland shows a markedly richer flora than the eastern part at latitude, 52°20' N, and this fact is reflected in the presence of *Picea glauca* and in the composition of the *Populus tremuloides* understory vegetation of the Big Knife area. Some of the species occurring here are *Agrimonia striata*, *Shepherdia canadensis* and *Lysimachia ciliata*.

Location 21, near Big Knife Provincial Park, marks the western boundary of the study area and the eastern limit of *Picea glauca* at this latitude. Most of the collections were made in the flood plain and slopes of the Battle River. The mature *Picea glauca* formed a closed canopy forest which allowed very few species of vascular plants to grow underneath it. The ground and the rotting logs under *Picea glauca* were covered with a variety of mosses and lichens including *Eurynchium pulchellum*, *Brachythecium salebrosum*, *Thuidium recognitum*, *Mnium cuspidatum*, *Polytrichum juniperinum*, *Parmelia flava*, *P. sulcata*, *Xanthoria fallax* and *Peltigera canina*. Such epiphytes as *Usnea hirta*, grew on dead *Salix* sp. branches.

A marked contrast with the moist forest floor was provided by the steep south facing slopes rising out of the flood plain. Some of the species found here were *Bouteloua gracilis*, *Muhlenbergia cuspidata*, *M. racemosa*, *Petalostemon purpureum*, *Psoralea argophyla*, *Gutierrezia sarothrae*, *Atriplex nutalliana* and *Artemisia longifolia*.

The open grassland vegetation in the floodplain consisted mainly of *Agropyron subsecundum*, *A. smithii*, *Helictotrichon hookeri*, *Agrostis scabra*, *Bromus anomalus* and *Anemone cylindrica*.

Location 18, in the Hand Hills and near Little Fish Lake, is situated at the western edge of the study area and at the boundary of the parkland and prairie. The gravelly deposits of the Hand Hills rise 200 m above the undulating ground moraine of the surrounding area. A small locality on a north- northwestern slope proved to be unusually rich in plants of moist habitats when compared to the dry lowlands of the surrounding prairie. *Populus tremuloides*, *Prunus virginiana* and *Salix* sp. form closed thickets. Some of the other plants collected were *Juniperus communis*, *Lilium philadelphicum*, *Smilacina racemosa*, *Zygadenus elegans*, *Z. gramineus*, *Actaea rubra*, *Anemone multifida*, *Thalictrum venulosum*, *Ribes oxyacanthoides*, *Spirea alba*, *Hedysarum alpinum*, *Lathyrus ochroleucus*, *Viola rugulosa*, *Shepherdia canadensis*, *Heracleum lanatum*, *Osmorhiza depauperata*, *Sanicula marilandica*, *Zizia aptera*, *Cornus stolonifera*, *Pyrola asarifolia*, *Arctostaphilos uva-ursi*, *Castilleja miniata*, *C. septentrionalis*, *Penstemon nitidus*, *P. procerus* and *Viburnum edule*.

At the southern end of the Hand Hills the Fish Creek flows into the Little Fish Lake. The muddy floodplain provides habitat for a number of semiaquatic and meadow plants, as exemplified by *Sagittaria cuneata*, *Phleum pratense*, *Poa palustris*, *Eleocharis palustris*, *Juncus balticus*, *Hippuris vulgaris*, *Sium suave*, *Dodecatheon radicatum*, *Mentha arvensis*, *Stachys palustris* and *Antennaria pulcherrima*.

Mixed prairie

The treeless grassland of southern Alberta occupies the brown and part of the dark brown soil zones (Moss 1955), and it forms the northwestern tip of the Great Plains of North America. The term "mixed prairie" has been applied by Clements (cit. by Coupland 1952) to the *Stipa*-*Bouteloua* association of western Canada, as distinguished from the true prairie occupied by the *Stipa*-*Sporobolus* association east of longitude 100. Clark et al. (1942) perpetuated the term "short-grass prairie" which they considered to be the xeric type of the mixed prairie association, containing *Bouteloua gracilis*, *Poa secunda*, *Carex filifolia*, *Stipa comata*, *Agropyron smithii* and *Koeleria cristata*.

Coupland (1952) defined five faciations within the *Stipa bouteloua* association. The *Stipa*-*Bouteloua* faciation is typical of intermediate slopes and medium textured soils. The *Bouteloua*-*Stipa* faciation characteristic of the medium to coarse textured soils and of exposed locations. The *Agropyron*-*Koeleria* faciation occurs on glacio-lacustrine clay deposits. The clay-loam solonetzic soils are vegetated by the *Bouteloua*-*Agropyron* faciation. The *Agropyron*-*Muhlenbergia* facies forms a subclimax on eroded glacial till. Coupland (1952) noted that *Bouteloua gracilis* and *Artemisia frigida* have become dominant species on overgrazed pastures. Collection sites investigated in the mixed prairie are: 31 Hand Hills, 32 Oyen, 34 Empress, 37 Schuler, 36

Sandy Point on the S. Saskatchewan River, 38 Chappice Lake, 39 Walsh 40 Seven Persons, 47 Writing-on-Stone, 42 Chin Coulee, 35 Dinosaur, 22 HW 36 x Battle River, 30 Altario, 48 Onefour, 44 Grant Creek, 50 Aden, 45 Orion

Collection areas 34 and 36, located in the Empress district, were among those studied in some detail. These locations lie very near the Saskatchewan border which forms the eastern boundary of the study area. This is the driest part of Alberta with mean yearly precipitation of only 226 mm with frequent occurrences of drought (see Fig. ...). Most of the collections were made in coulees where the extra moisture supports a greater variety of plants than the surrounding uplands. A narrow, steep sided coulee was vegetated by dense thickets of *Rhus trilobata* and *Prunus virginiana*. The understory consisted mainly of *Ribes oxyacanthoides* and *Smilacina stellata*. The vegetation of the broad coulees was mixed grassland of *Stipa*-*Koleria*-*Bouteloua* association with extensive patches of *Symphoricarpos occidentalis* at the bottom of the coulee. Some of the forbs associated with the grassland were *Astragalus bisulcatus*, *Oxytropis sericea*, *Psoralea argophyla*, *P. esculenta*, *Eriogonum flavum* and *Hymenoxis richardsonii*. Five km north of Empress several semiaquatic and marsh plants were collected. Some of these were *Sagittaria cuneata*, *Calamagrostis inexpansa*, *Hippuris vulgaris*, *Collomia linearis* and *Scirpus validus*. *Populus sargentii* was collected on the floodplain of the Red Deer

River. *Elymus canadensis*, *Salix interior* and *Artemisia biennis* were also found growing in sandy soil near the river bank.

Collections at location 36, Sandy Point on the South Saskatchewan River were made on the floodplain as well as on the eroded river bank. The floodplain vegetation included several salt tolerant plants such as *Distichlis stricta*, *Rumex maritimus*, *Chenopodium glaucum* ssp. *salinum*, *Suaeda depressa* and *Agrostis scabra*.

One of the most characteristic plants of eroded banks in southeastern Alberta is the shrub *Sarcobatus vermiculatus*. Herbaceous plants associated with it were *Hymenoxys richardsonii* and *Eurotia lanata*. In moist draws *Clematis ligusticifolia* makes its appearance.

South of Sandy Point there are several sand dune areas. Stunted *Populus tremuloides* grows in the depressions, about 150 km south of its limit in the aspen grove belt. The trees are able to make use of the groundwater supply within the reach of their roots.

Location 21, west of Schuler, is an upland site 45 km northeast of Medicine Hat. McPherson and Berg (1972) show the area as hummocky moraine. The undulating topography offers little variation in habitats. The vegetation is lightly grazed mixed grass prairie with *Agropyron trachycaulum*, *Koeleria cristata*, *Stipa spartea* var. *curtiseta*, *S. viridula*, *Orthocarpus luteus*, *Astragalus agrestis* and *Potentilla gracilis*. In the shallow depressions *Agropyron smithii* is found with *Zygadenus gramineus*, *Poa palustris* and *P. juncifolia*. On the sandy roadsides *Rosa arkansa* and *Lactuca pulchella* were collected.

Locations 38 Chappice Lake and 39 Walsh are shallow saline sloughs approximately 30 km northeast of Medicine Hat. Chappice Lake is a small depression in an area covered by ground moraine. Many Island Lake at Walsh was a group of dried up slough bottoms in 1976. The parent material is lacustrine sand and silt (McPherson and Berg 1972). *Equisetum laevigatum*, *Distichlis stricta*, *Suaeda depressa*, *Beckmannia syzigachne*, *Puccinellia nuttalliana*, *Deschampsia caespitosa*, *Poa palustris*, *Ranunculus cymbalaria* were characteristically present. In a roadside slough surrounded by *Salix* sp. *Alopecurus geniculatus*, *Deschampsia caespitosa*, *Poa palustris*, *Plygonum coccineum* and *Stachys palustris* were collected.

Location 40 is situated in the Seven Persons area, 25 km southeast of Medicine Hat. Collections were made on hummocky moraine, ground moraine, glaciofluvial and glaciolacustrine sites. The upland sites were vegetated by mixed prairie with *Stipa comata*, *Koeleria cristata*, *Bouteloua gracilis*, *Atriplex nuttalliana*, *Geum triflorum*, *Astragalus pectinatus*, *Plantago patagonica*, *Comandra pallida*, *Eriogonum flavum*, *Endolepis suckleyi*, *Cymopterus acaulis*, *Erysimum inconspicuum* and *Artemisia frigida*. In the depressions *Agropyron smithii* dominates and on dry slopes *Artemisia longifolia*, *Haplopappus nuttallii*, *Haplopappus spinulosus*, *Hymenoxys richardsonii*, *Chrysopsis villosa*, *Chrysosamnus nauseosus*, *Erigeron caespitosus* and *Grindelia squarrosa* are frequent.

In moist draws and protected slopes *Agropyron inerme*, *A. spicatum*, *Stipa viridula*, *Danthonia intermedia*, *Bromus anomalus*, *Poa pratensis*, *Penstemon nitidus*, *Heuchera richardsonii*, *Amelanchier alnifolia*, *Fragaria verginiana*, *Potentilla gracilis*, *Astragalus bisulcatus*, *Linum lewisii*, *Epilobium glandulosum*, *E. paniculatum*, *Androsace septentrionalis*, *Collomia linearis*, *Plantago major*, *Arnica sororia* and *Senecio canus* are found.

Some of the aquatic and semiaquatic plants collected in a shallow creek bed were *Alisma plantago-aquatica*, *Alopecurus aequalis*, *Calamagrostis inexpansa*, *Deschampsia caespitosa*, *Glyceria borealis*, *Polygonum coccineum*, *P. lapathifolium*, *Rumex mexicanus*, *Ranunculus aquatilis* var. *capillaceus*, *Mentha arvensis* and *Stachys palustris*.

Collection site 47, located in the Writing-on-Stone and Deer

Creek district, represent the southwesternmost locations in the study area. The surface deposit is composed of glacial till derived from local sandstones and shales of the Milk River formation. Parts of the bedrock have been exposed by erosion and form "badlands". Habitats for the different plant communities are provided by the upland sites, eroded slopes and the alluvial flats. The vegetation on the undulating upland is mixed prairie, characterized by *Stipa comata*, *S. Spartea* var. *curtiseta*, *Koeleria cristata*, *Agropyron smithii*, *Carex filifolia*, *Eriogonum flavum*, *Eurotia lanata* and *Oxytropis sericea*. According to de Vries (1968), *Heuchera flabellifolia* and *Solidago missouriensis* var. *extraria* are considered to be of the Cordilleran element. Species typical of sandy sites are *Juniperus horizontalis*, *Rumex venosus*, *Petalostemon candidum*, *Asclepis viridiflora* and *Mentzelia decapetala*. The latter species was collected only at this location.

The Deer Creek coulee, like most streambanks in southern Alberta, is characterized by the presence of *Populus sargentii*, *Clematis ligusticifolia* and *Ribes aureum*. Other species favoring the moist habitat under *Populus sargentii* are *Salix* sp., *Cornus stolonifera*, *Potentilla anserina*, *Heracleum lanatum* and *Habenaria viridis*. *Elymus cinereus*, an uncommon plant restricted to some moist locations in the southernmost part of Alberta, was also collected here. On the erodedslopes *Lesquerella arenosa* and the uncommon

Oenothera serrulata can be found.

The boreal-montane vegetation of the Cypress Hills was described in detail by Breitung (1954) and by de Vries and Bird (1968). No collections were made in the region during the course of this study.

HISTORY OF THE FLORA

Until the late Eocene the climate of Alberta was tropical and subtropical as indicated by the presence of coral beds and the remains of warm-climate animals and plants (Stelck 1967). By the end of the Eocene epoch the climate was characterized by increased humidity and cloudiness, less intense interzonal circulation, higher oceanic temperatures and the shrinking of polar icecaps. The higher precipitation and less variation between seasons gave rise to a mixed mesophytic forest widespread in the northern hemisphere (Wolfe and Leopold 1967; Wolfe 1972).

This mixed forest extended from Japan and central China to Alaska and northwestern North America and included such genera as *Ulmus*, *Cocculus*, *Liquidambar*, *Platanus*, *Magnolia*, *Cinnamonum* and *Litsea*. Asa Gray was the first one to call the attention to the resemblence between floras of eastern United States and eastern Asia (Li 1952). He concluded that the extant mesophytic vegetation of the Appalachian Mountains and of central China and Japan are the remnants of the mesophytic forest which occupied large areas in the Northern Hemisphere during Tertiary times. The name Arcto-Tertiary Flora and later Arcto-Tertiary Geoflora was given to the vegetation on the basis of its origin and extent (Chaney 1959). Johnson et al. (1965) pointed out that even during the Miocene, colder climates and therefore somewhat different vegetation must have prevailed at higher latitudes and altitudes. Wolfe (1972) rejected the idea that "geofloras" or floristically uniform groups of temperate plants maintained their composition for several epochs of earth history. Although Mixed Mesophytic forests were widespread during the Miocene, their evolution from the tropical and subtropical forests of the Eocene and early Oligocene were independent of each other in the various regions and so their taxonomic composition also varied.

Wolfe and Leopold (1967) called the similarity between the Alaskan Seldovian floras and the early and middle Miocene floras of Japan and Oregon "remarkable". Some species which are extinct today but were widely distributed during the Tertiary are *Populus kenaiana*, *Populus reniformis*, *Comtonia naumani*, *Carya bendirei*, *Pterocarya nigella*, *Alnus fairi*, *Fagus antipofi*, *Quercus bretzi*, *Quercus axelrodi*, *Ulmus newberry*, *Zelkova oregoniana*, *Cercidiphyllum cretanum*, *Cocculus auriculata*, *Liquidambar mioformosana*, *Platanus bedirei*, *Cladrastis japonica*, *Acer ezoanum*, *Acer fatisiaefolia*, *Acer chaneyi*, *Acer glabradoides*, *Acer macrophyllum*, *Aesculus majus* and *Viburnum latanifolium*. Wolfe and Leopold (1967) also stated that "...the floristic histories of northeastern Siberia and Alaska are essentially the one and the same ..". MacGinitie (1941) noted that the Chalk Bluff deposits of Sierra Nevada contain many species that are closely allied to species of the Tertiary floras of

Alaska. An Upper Eocene warm temperate or even subtropical flora from Kupreanof Island contains *Ceratozamia*, *Flabellaria*, *Castanopsis longipetiolum*, *Magnolia*, *Ocotea*, *Rhamnus* and *Dillentes*. MacGinitie (1941) further wrote that other localities contain "abundant remains of *Salix*, *Betula*, *Corylus*, *Alnus*, *Fagus*, *Quercus* etc. associated with *Sequoia*, indicating a humid, temperate climate similar to that of southwestern England. The Alaskan flora is largely composed of the temperate Holarctic element which probably occupied its most northernly position during the warm climates of the Upper Eocene...".

Chaney (1959) noted the similarity between the Upper Miocene floras of western America and the extant mesophytic forests of eastern America. He wrote that "...the forest now living on the Appalachian Mountain slopes contains more equivalent living species (to the Tertiary Mascall flora of Oregon) than any other...". Extant eastern Asian genera are also well represented in the Miocene floras of western America. 36 genera, representing 78% of the Mascall flora, are found in central China. These include *Acer*, *Albizzia*, *Fagus*, *Gingko* *Liquidambar*, *Metasequoia*, *Nyssa*, *Sassafras* and *Zelkova*. Chaney (1959) considered the forests of western Hupeh and adjacent Seczhuan in central China representatives of "a relatively complete surviving example of the Arcto-Tertiary Geoflora..." showing a "striking resemblance" to the Middle Tertiary floras of western North America. Li

(1952) examined in detail the related floras of eastern Asia and eastern North America. He reviewed Gray's "identical species" and followed up further work on the floristics of the "Tertiaro-Mesophytic" elements.

The related species of eastern Asia and eastern North America have not been interpreted by all as remnants of Tertiary floras. Iltis (1973) and others (cit. by Iltis 1973) explain the "Arcto-Tertiary" floristic disjunction patterns by the process of inter-hemispheric long distance dispersal and "unique ecological equivalence" of the related regions.

Climatic and vegetational changes during the Neogene. Wolfe and Leopold (1967) traced the Neogene climatic history as indicated by the plant records. They felt that Neogene associations of Liquidambar, Nyssa, Fagus, Quercus, Tilia and Ulmus indicate that their climatic tolerances were not significantly different in the Neogene than they are today. Wolfe and Leopold (1967) considered the average July temperature to be indicative of the factors which caused the replacement of one forest type by another. The geographical limits of Abies, Picea, Tsuga and Pinus closely parallel definite isotherms and therefore the fossil remains of these trees can be reliably used in the interpretation of Neogene climates although in the case of some genera, such as Platycarya and Cercidiphyllum Wolfe and Leopold (1967) consider it dangerous to apply the tolerances of the living species to the interpretation of Paleoclimates.

The late Oligocene - early Miocene climates of Alaska (Wolfe and Leopold 1967) and northwestern United States and British Columbia (Chaney 1959) were warm, with an average July temperature of at least 20-21°C at the coast and higher in the interior, as evidenced by the presence of *Nyssa* and *Liquidambar*, and not higher than that, as shown by the local presence of *Picea* in Alaska.

Tanai (1961) wrote that at the same time "the late Oligocene floras (of Japan) consisted mainly of temperate or warm-temperate vegetation including *Metasequoia*, *Glyptostrobus*, *Cephalotaxus*, *Populus*, *Quercus*, *Platanus*, *Acer*, *Crataegus*, *Smilax*, *Alangium etc*. ". By the middle Miocene (late Seldovian) the average July temperatures of Alaska must have dropped below 18°C (Wolfe and Leopold 1967), as indicated by the extinction of *Juglans*, *Fagus*, *Quercus*, *Liquidambar* and *Nyssa*. This climatic change was not paralleled in Japan (Tanai 1961) where the flora changed from warm-temperate to temperate. Deciduous broadleaved trees, such as *Betula*, *Alnus*, *Carpinus* *Ulmus*, *Zelkova*, *Fagus*, *Acer*, *Tilia*, *Salix* dominated but temperate conifers, such as *Picea*, *Abies*, *Taxodium* *Metasequoia* and *Glyptostrobus* were also present.

By the late Miocene the summer temperatures dropped. Wolfe and Leopold (1967) estimate that the average July temperature dropped 7°C in 4 million years. A boreal forest replaced the mixed mesophytic forest "apparently going through the transitional Northern Hardwood Forest ..." (Wolfe and Leopold 1967). *Nyssa*, *Liquidambar* and other warm-climate hardwoods disappeared from Alaska and were replaced by members of Pinaceae. The forests of eastern Asia, Alaska and the Pacific Northwest became disjunct. The remains of the rich boreal forest of the late Miocene exists today in the Amur River valley and in coastal Oregon and Washington, though the coniferous forests of Siberia and North America have never been continuous. During most of the Miocene the Bering Strait was open, inhibiting floristic interchange between the two continents.

The climate of Japan also cooled during the late Miocene and early Pliocene and many warm or exotic elements, such as *Metasequoia*, *Glyptostrobus*, *Sequoia* and *Liquidambar* disappeared from there (Tanai 1961). The Japanese islands began to show regional diversities but the climatic and vegetational changes have not been nearly as cataclysmic as in Alaska and the Pacific Northwest. In western North America the uplift of the Cascade Range placed the Columbia Plateau in a rainshadow (Chaney 1959). Precipitation was reduced and the temperature varied between greater extremes, causing the extinction of many genera during the Pliocene epoch. The uplift of the Rocky Mountains during the Tertiary had a similar effect on the climate and vegetation of the Great Plains, and some former residents of western America survived only in eastern Asia and eastern America where the climate and topography remained similar to those of Tertiary times. Table 5 summarizes the climatic and vegetational changes during the Neogene.

Other plants have evolved and adapted to the changing climate of the Quaternary. Tolmatchev (cit. by Johnson et al. 1965) suggested that as conditions became unfavorable in Alaska for temperate trees such as Sequoia, Acer and Ulmus, suitable habitats for high altitude herbaceous perennial ancestors expanded. Johnson and Packer (1967) envisaged a circumpolar arctic-alpine tundra at the latitude of Alaska during the Tertiary "upon which Pleistocene events have been superimposed."

The Quaternary.

The general cooling trend which began in the late Eocene (Daugherty 1968) culminated in the cold, dry and unstable climate of the Quaternary. Cold periods, during which glaciers built up and the sealevel dropped, alternated with warmer periods when the glaciers receded and the sealevel rose. In the past two million years four glaciations occurred in North America (see Table 6.): the Nebraskan, Kansan, Illinoian and Wisconsin. According to Bayrock (1967) "only the Wisconsin ice sheets covered this (Alberta) region

TABLE 5.

CLIMATIC AND VEGETATIONAL HISTORY IN LATE TERTIARY AND QUATERNARY PERIODS

	Years B.P.	Events
QUATERNARY	600,000	Ice ages begin in Europe (Cooke 1973)
	1 m. y.	Tundra vegetation in Beringia (Hopkins 1972)
		Ice ages begin in N. America (Cooke 1973)
	2 m. y.	Severe frost on Pribilof Island (Hopkins 1972)
TERTIARY	3 m. y.	Significant cooling
	4 m. y.	Bering Land Bridge severed (Hopkins 1967 p. 458.)
		Nearly all broad leaved deciduous trees become extinct. Glaciation of Alaskan mountains. Western North America has drier summers (Wolfe 1969).
		Dispersal of land mammals accross the Bering Land Bridge (Hopkins 1967).
		Fagus forest in Alaska (Hopkins 1972)
	10 m. y.	Bering Land Bridge reestablished (Hopkins 1972).
		Bering Land Bridge severed; Boreal forest in Alaska; Temperature 11 - 14° C (Wolfe and Leopold 1967)
	14 m. y.	Extinction of Magnolia, Cocculus etc. in western North America; Temperature 14 - 17°C
	19 m. y.	Mesophytic mixed forest is widespread; Temperature 18 - 21°C (Wolfe and Leopold 1967).

TABLE 6.

GLACIATIONS OF NORTH AMERICA

Years B. P. x 1000	Wisconsin glacial stades	Glaciations and interglacials
11	Valderan	WISCONSIN
	Twocreekan interstade	
	Woodfordian	
22	Farmdalian interstade	
28		
	Altonian	
70		Sangamon interglacial
400		ILLINOIAN
		Yarmouth interglacial
1300		KANSAN
		Aftonian interglacial
		NEBRASKAN
1800??		

After Westgate (1965, 1968) and Cooke (1973).

and ... during all previous glaciations the terrain from Montana to the Arctic Ocean along the Rocky Mountains was free of ice".

Pre-Wisconsin vegetation

According to Wright (1971) pre-Wisconsin vegetational history is not well known because few detailed pollen diagrams are available for early and middle Quaternary sites. The Don beds near Toronto indicate temperate forest with *Liquidambar* during Sangamon time. In southern Illinois "a rich south-temperate forest existed during the same period (E. Grüger cit. by Wright 1971).

J. Grüger (1973) suggested that the Farmdalian vegetation, which preceded the Woodfordian spruce forest, contained *Alnus*, *Salix*, *Betula*, *Pinus*, *Corylus*, *Quercus*, *Ulmus*, *Fraxinus* with high values of non-arboreal pollen

Colinvaux (1964) suggested that from pre-Illinoian times Beringia supported only shrub tundra with dwarf *Betula*, *Alnus* and *Picea* near the coast. During the Illinoian glaciation the tree line receded to eastern Alaska and a herbaceous tundra remained. The Bering land bridge and eastern Siberia were covered with arid steppe-tundra which contained *Artemisia*. The beginning of the Wisconsin ice age has been tentatively dated around 70,000 B.P. (Westgate 1968; Dreeszen 1968). Recent improvements in radiocarbon dating places the St. Pierre interstade of the Great Lakes region "very early in the Wisconsin" to approximately 75,000 B.P. (Stuiver et al. 1978). This date represents the onset of climatic deterioration after the previous interglacial and correlates well with the increase in marine oxygen 18 isotope, interpreted to mean the removal of water from the oceans during the course of glacier buildup. The cooling of the climate and the buildup of glaciers did not proceed at an even pace. The fluctuation in temperature caused the retreat of the Wisconsin ice sheet during its numerous interstades as early as 71,000, 65,000 and 60,000 radiocarbon years ago. These climatic and glacial events were widespread, as shown by the good correlation between data from the Pacific North West of America and results from Europe and south America (Stuiver et al. 1978). The three interstades were followed by a pronounced cold interval around 55,000 years ago and then by a warming trend which culminated in an interstade between 50,000 and 40,000 years ago (Stuiver et al.1978). The above mentioned fluctuations present a more complex picture of the early Wisconsin than the Altonian substage lasting from 70,000 till 28,000 B.P. and culminating in the Farmdalian interstade, as was suggested by Frye and Willman (cited by Westgate 1968). Westgate (1968) dates the last major advance of the Laurentide ice sheet into Alberta at approximately 21,000 years ago, marking the end of the Farmdalian interstade and the beginning of the "classical" Wisconsin which lasted till about 15,000 B.P. During this period, the Woodfordian substage of Frye and Wilman (cit. by Westgate 1968), the Wisconsin ice sheets reached their maximum extent.

The Laurentide ice sheet, which covered eastern Alberta, originated from northwest of the Hudson Bay. The general direction of the ice flow was towards the southwest, as shown by the orientation of drumlins, flutings, erratics and height of glaciation (Gravenor and Bayrock 1965), but in central and southern Alberta the flow was gradually deflected towards the south and then to the southeast. The direction of the ice movement was further modified by the local terrain (Westgate 1968). Although the Alberta plain was covered with glacial ice approximately 1500 m thick in the central part of the Province, the 1440 m high Cypress Hills were glaciated only to the 1230 m level on the north side and 1100 m on the south. Gravenor and Bayrock (1955) concluded that the ice surface was almost flat across southern Alberta.

During the glacial maximum the Laurentide icesheet reached western Alberta and coalesced in several places with glacier lobes originating in the Rocky Mountains (Reeves 1973; Roed 1975). Both Reeves and Roed concluded that the duration of the coalescence was only about 2000 years and, for the rest of the Wisconsin, there was a north-south ice-free corridor from the Arctic ocean to the 49th parallel, allowing the movement of biota during late Wisconsin times. Rutter (1978) and Stalker (1978) suggest that the Cordilleran and Laurentide glaciers coalesced at different locations and different times opening part of the corridor and closing the other. The ice free areas thus shifted in an approximate north-south as well as an east-west direction with spurs of ice protruding into the open areas. They also suggest that the contact between the two ice sheets was more extensive north of the 54th parallel.

LATE PLEISTOCENE AND HOLOCENE VEGETATIONAL HISTORY.

Research into the vegetational history of the recent past has depended on pollen stratigraphy (Ritchie 1976), the identification and radiocarbon dating of macrofossils (Colinvaux 1967), buried soils (Ruhe 1968; Dormaar 1976) and floristic and cytological analysis of extant vegetation (Löve 1959; Johnson and Packer 1967). Results provided by the above disciplines have been correlated with data from geology, climatology (Bryson et al. 1968) and oceanography (Stuiver et al. 1978).

In spite of its shortcomings (Ritchie 1976), the analysis of the relative frequencies of fossil pollen grains from core samples of various sediments has provided the backbone for the reconstruction of the recent past. Pollen preservation depends on suitable conditions and sites which are apparently lacking in the study area. Ritchie (1976) remarked that "the record of vegetation history for the grassland-aspen parkland region is sparse and several sites show serious gaps in the pollen stratigraphy. Hummocky disintegration moraine, the dominant landform in the area, provides numerous sedimentary basins, but few of them have complete records".

Survival of plants in unglaciated areas

The location and extent of unglaciated areas are important because these were potential sources of plants which revegetated Alberta following Pleistocene extinctions. The extent of glaciation in North America is depicted by Prest (1969, 1976) and by Bryson and Wendland (1967) (see also Fig. 10.). The only unglaciated enclave within the study area is the Cypress Hills plateau, but even here plant survival during the glacial maximum is most unlikely (Thompson and Kuijt 1976). Although neither the Cypress Hills plateau nor the buttes of the Sweetgrass Hills were glaciated during Wisconsin times, there is evidence that the complex forest vegetation did not survive *in situ* while surrounded by glaciers. Westgate (1972) pointed out that "well developed periglacial structures testify to the rigorous climate that once prevailed in this region". Elongate pebbles which moved into highly inclined positions, involutions and frost wedges point to "dry, very cold conditions when permafrost was well established in the area". Although in the absence of direct evidence one cannot exclude the possibility that some plants may have survived, the present boreal-montane vegetation is thought to have come by gradual migration.

Johnson et al. (1965) wrote that "a great part of Alaska remained unglaciated during the Pleistocene. This includes almost all of the interior between the Alaska Range and the Brooks Range and nearly all of the west and north coast. Scattered mountain glaciation occurred on the highest of interior mountains and probably also on the mountains of the Seward Peninsula. Vegetation grew in these areas during all of the Quaternary...". Phytogeographical evidence by Hultén (1937) and subsequent work in geology and palynology (Colinvaux 1964) showed that during the Quaternary the sealevel dropped sufficiently to expose a broad land bridge, about 1500 km wide, between Siberia and Alaska. This landbridge served as a migration route for plants, animals and humans between the two continents (Hopkins 1967).

In late Pleistocene times the sea level oscillated between 50 and 15 metres below present levels, roughly in accordance with the melting and readvance of the Wisconsin glaciers. About 10,000 B.P. the sea inundated the Bering land bridge and severed the connection between the two continents for the last time (Hopkins 1967). As Hultén (1937) showed, the Alaska-Yukon area served as an important source of biota in post-Pleistocene migrations into northern Canada. Later evidence (Hopkins 1967; Colinvaux 1968; Johnson et al. 1965; Johnson and Packer 1967; Cody 1971) provided further evidence supporting Hultén's assessment.

The continental shelf and such adjacent areas as the Queen Charlotte Islands (Calder and Taylor 1968; Schofield 1969) were ice free and have allowed the survival of some of the vegetation, maintaining continuity with Tertiary plant life. When northern North America was covered by thick ice, the northern and northeastern part of the Arctic Archipelago remained unglaciated (Porsild 1955), with a climate suitable for the survival of a relatively rich arctic flora. Porsild (1955) cites Simmons' contention that the climate during the Pleistocene was probably too arid in the Arctic Archipelago for glaciers to develop, yet, due to the effect of the ocean, mild enough for plant survival. During the glacial retreat, when plants from the south and west rapidly advanced over the ice-free areas (Ritchie 1976), the Arctic Archipelago remained isolated and unavailable as a source of colonizing plants. Ives (1978) discussed the controversy over the northern extent of the Laurentide ice sheet and the probability that the ice-free areas were much smaller than assumed by Porsild (1955).

Several small refugia have been noted in the Rocky Mountains (Packer and Vitt 1974). These high altitude alpine enclaves probably did not play an important role in the revegetation of the prairie and parkland, but may have supplied source material for the recolonization of the Cypress Hills (Breitung 1954).

My study suggests that the only area which can be shown to have been a source of plant material for revegetation lay south of the boundaries of the Wisconsin glaciers. Palynological evidence (Wright 1971; Grüger 1973; Bernabo and Webb 1976) indicated that a species poor _Picea_ forest formed a broad belt accross the continent during the glacial maximum of the Wisconsin ice age between 23,000 and 14,000 B.P., replacing the rich deciduous forest which covered the area during Sangamon times.

During the maximum of the Wisconsin glaciation the cold and dry climate caused the extinction of _Pinus banksiana_ and its retreat to the southern Appalachian region (Wright (1971). Grüger (1973) described 2 pollen profiles from northeastern Kansas and showed a sharp increase in _Picea_ pollen and a gradual decline of _Pinus_ pollen beginning 24,500 +- 800 B.P., a date approximating the end of the Farmdalian interstade and the beginning of the Woodfordian glacial stade. Grüger (1973) suggests that there may have been a transitional _Populus-Alnus_ band adjacent to the _Picea_ forest. Hott (1976) emphasized the importance of _Populus_, especially _Populus tremuloides_, in the revegetion of formerly glaciated areas. Mott (1976) suggested that "... in the depauperate flora of the past, *Populus* formed a very prominent part of the total vegetation but *Populus* trees were not as numerous in the landscape as they are today in central Saskatchewan... A more or less open environment with *Populus* occurring not as a closed forest but as groves or clumps on suitable sites where they could gain a foothold is envisage for late-Pleistocene time ".

The existence of a periglacial tundra vegetation remains controversial. Wright (1971) observed that late glacial tundra has been identified only in New England and in northeastern Minnesota, based on high values of non-arboreal pollen deposits, namely fossil pollen of Cyperaceae, *Artemisia*, *Ambrosia*, Gramineae and on macrofossils of *Dryas integrifolia*, *Vaccinium uliginosum* var. *alpinum*.

The location and aerial extent of prairie grassland remains obscure (Wright 1971). Wells (1970) suggested that no treeless grassland existed south of the band of *Picea* forest, but "an open, xerophylous woodland of pinon pine, *Pinus ambroides* var. *remota*, live oaks and juniper prevailed during Wisconsin time". Wells (1970) further cited "several pollen profiles from Wisconsin-age sediments (which show) very high contents of pine pollen ..." in the southern part of the Texas panhandle.

Schweger of University of Alberta (pers. comm.) suggested that the survival of prairie grasses do not necessarily mean the existence of continuous prairie south of the Wisconsin ice sheets. The rolling and undulating terrain may have supported patches of deciduous shrub-tree vegetation and grassy clearings. Mott (1976) also suggested "a more or less open environment with Populus occurring not as a closed forest but as groves or clumps on suitable sites ...".

Deglaciation

The time of retreat of the Keewatin ice sheet of the Wisconsin is difficult to ascertain because between 15,000 and 10,500 B.P. the glaciers oscillated within a range of few hundred miles (Bryson et al. 1968; Westgate 1968), but then began a rapid retreat towards the northwest. The ice disappeared first from southwestern Alberta at approximately 15,000 B.P. (Ritchie 1976; see also Fig. 10.). In addition to its horizontal retreat, the icesheet became progressively thinner. The climatic trend which caused the melting was world-wide, but regional and local climates were also important in controlling advances and retreats. Bryson et al. (1968) suggested that in late glacial times the westerly winds intensified and the arctic fronts began to shift northward, causing summer temperatures to be warmer than the global trend would justify. They propose that 10,500 B.P. should mark the end of the Pleistocene and the beginning of the Holocene.

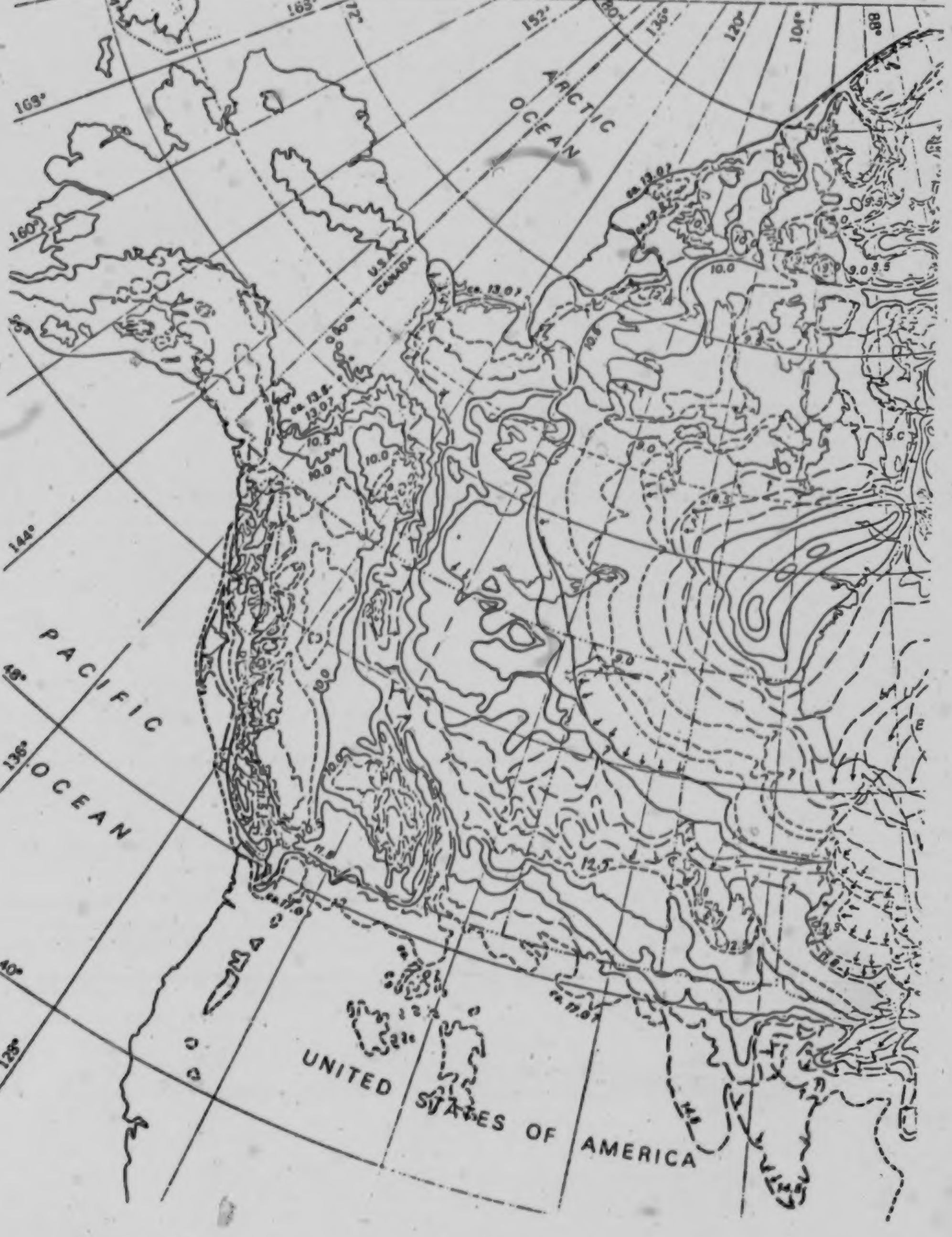

168°
152°
136°
120°
104°
88°
160°
144°
48°
136°
40°
128°
ARCTIC OCEAN
U.S.A.
CANADA
PACIFIC OCEAN
UNITED STATES OF AMERICA
10.0

Fig. 10. Stages in the deglaciation of the Wisconsin ice sheets. From Prest (1976).

The debris removed by glaciers was carried in subglacial, englacial and superglacial position. Subglacial materials were deposited as endmoraines at frontal ice margines where the rate of glacial advance equalled the rate of melting. Most of the study area is characterized by hummocky or dead ice moraine with knob and kettle topography. Hummocky moraine is the result of uneven melting of glacial ice, slumping and the resulting differential letdown of superglacial and englacial debris. Material covering the ice may have delayed complete melting for several thousands of years (Clayton 1967). Wright (1976) described the process as follows: "Most moraines retain masses of buried ice, which may persist for thousands of years. The ice slowly melts down when the protective mantle of rock debis is removed by slumping or some other accidental disturbance, but the downwastage is irregular".

The large amount of water released during glacial melting accumulated in superglacial, proglacial and glacial lakes where ground features or iceblocks interfered with drainage. According to Wright (1976) "The entire moraine may be lowered irregularly ... with numerous topographic reversals and the development of small plateaus of lake sediment bounded by ice-contact slopes. The lake does not persist as a permanent feature ... until all the ice beneath has melted".

Flowing water left its marks as eskers, kames, outwash plains and meltwater channels (see section on surface geology).

Revegetation of deglaciated terrain

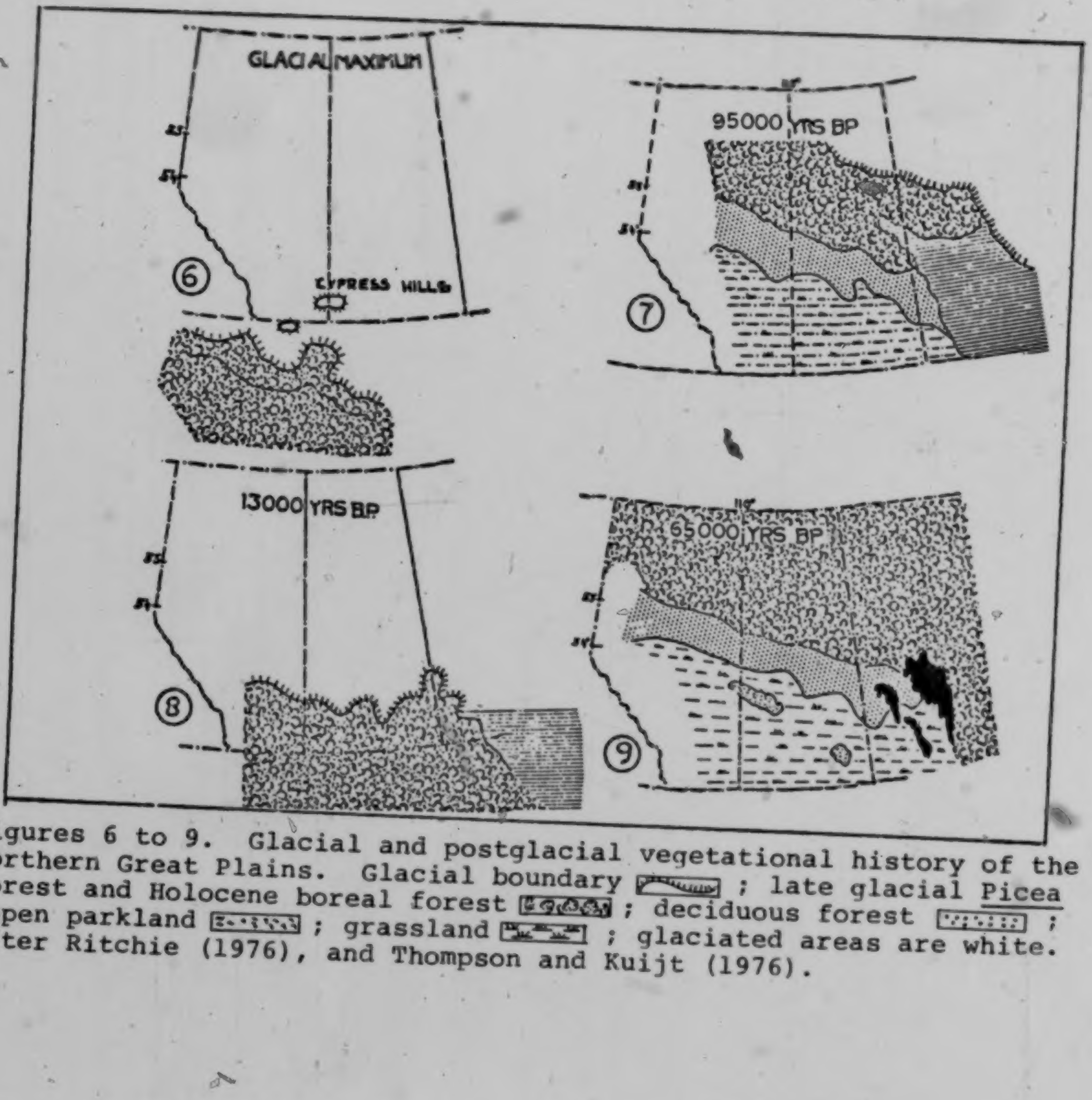
The earliest stages of revegetation are usually not recorded because the permanent and deep lakes or ponds in which pollen and other fossil material accumulate did not form until glacial melting was complete (Terasmae1974). It is not known therefore whether or not a herbaceous marsh or tundra type vegetation preceded the advance of Populus and Picea forests (Wright 1971, 1976). Since there were various kinds of habitats available, it is probable that they were utilized by aquatic, semi-aquatic and upland type vegetation.

In central Minnesota a herb tundra covered the region after deglaciation, followed by shrub tundra and forest tundra (Wright 1976). A brief interval of treeless herb-tundra was also recorded in what is now boreal forest in west-central Canada but, according to Ritchie and Yarranton (1978), "such a herb-tundra assemblage is absent from all sites recorded near and south of the modern northern boreal forest boundary.

A herbaceous pioneer vegetation may have preceded trees at a site located about 100 km north of the study area (Lichti-

Fedorovich 1970). Populus may have been the first trees invading the glacial debris, spreading both by seeds and suckers (Mott 1976). Mott envisages a "more or less open environment with Populus occurring not as a closed forest but as groves or clumps on suitable sites where they could gain a foothold ... (during) late-Pleistocene time". Along with Populus or shortly after Picea followed and formed a broad band of closed forest which may have spanned the Continent in an east-west direction (Ritchie 1976).

During late glacial times temperatures continued to rise and the westerly air currents continued to become stronger. The climate became warmer and drier, causing Picea to die out at its southern boundary, only to be replaced by grassland (see Figures 6-9). At the same time the forest advanced at about 200 to 300 m per annum towards the north (Ritchie 1976). The small enclaves of the boreal type forest present in the Cypress Hills, Sweetgrass Hills and Bearpaw Mountains are considered to have been part of the continuous boreal forest which was widespread in the Central Plains in early postglacial times (Breitung 1954; Thompson and Kuijt 1976). The northward movement of the late-glacial spruce-dominated "boreal forest" in eastern North America was mapped by Bernabo and Webb (1977). Between 11,000 and 9000 B.P. the norhtward movement of the southern edge of the Picea forest proceded faster than deglaciation and the forest was compressed to form a thin belt. In the Midwest the decline


GLACIAL MAXIMUM
CYPRESS HILLS
⑥
95000 YRS BP
⑦
13000 YRS B.P.
⑧
65000 YRS BP
⑨

Figures 6 to 9. Glacial and postglacial vegetational history of the Northern Great Plains. Glacial boundary ▨ ; late glacial Picea forest and Holocene boreal forest ▨ ; deciduous forest ▨ ; aspen parkland ▨ ; grassland ▨ ; glaciated areas are white. After Ritchie (1976), and Thompson and Kuijt (1976).

of *Picea* was extremely rapid, as indicated by the decline of *Picea* pollen from 50% to 5% in only a few hundred years. South of the *Picea* forest a region dominated by *Pinus* was expanding after 11,000 B.P.

In western Canada, near the southern limit of the modern boreal forest, the early *Picea* phase ended between 10,000 and 9000 radiocarbon years ago and was followed by grassland or parkland invading from the south. The boreal forest expanded southward about 3000 B.P. reinvading former grassland and parkland vegetation (Ritchie and Yarranton 1978). The arrival of *Pinus* altered the composition of the *Picea* forest. Both the timing and the origin of *Pinus* is difficult to ascertain because it produces large amounts of pollen which is carried far by the wind (Ritchie 1976). The general concensus is (Ritchie 1976; Wright 1968b) that *Pinus* spread from southern centres into Alberta, Saskatchewan and western Manitoba at the time of the general warming trend from the Boreal period onward. Ritchie (1976) places the arrival of *Pinus banksiana* at 7500 B.P. in northern Alberta, 6500 B.P. in eastern Saskatchewan, 5600 B.P. in northern Manitoba and 2500 B.P. in west-central Manitoba. Ritchie also suggests that "from 9500 to 6500 B.P. a narrow (50-100 km) belt of deciduous forest separated the northern boreal forest from the southern grasslands" (see Figures 6-9) and that the "modern boreal forest achieved its current composition and structure roughly 5 to 6000 years ago, and while its boundaries have shifted, it has remained constant since that time".

METHODS OF INVESTIGATIONS

Approximately 2400 numbered specimens were collected exclusive of duplicates. Sampling centred around fifty one localities lying approximately 70-100 km apart. Each of these localities was assigned a number listed in Table 2. In addition, some samples were collected at roadside points. No rigid pattern could be followed in determining sampling locations and their choice depended on the availablility of sites with minimum disturbance by human activities or livestock grazing. Such areas proved scarce in a region with relatively uniform topography and climate and extensive agricultural activities. The number of specimens collected at each locality depended on the diversity of its habitats. An attempt was made to collect a sample of all species within a three km radius of the sites considered most important for extending the distribution records.

The work was concentrated in the eastern and southern portions of the study area because relatively few botanical collections were available from that region. An exception to this is the Cypress Hills which has received much attention from botanists. No collections were made there during the course of this study. Nearly all sites were accessible by vehicle through the grid road system and through ranchers' trails. The National Topographic Series 1:250,000 maps proved valuable aids in navigation and in locating collecting sites. The map sheets used during the course of the field work are listed in Table 1.

The collected specimens were identified and compared with material in the herbarium of the University of Alberta. The identities of the specimens were confirmed or corrected by Dr. J. G. Packer. The voucher specimens were deposited in the herbarium of the University of Alberta (ALTA). Duplicate specimens were placed in the herbarium of Lakeland College, Vermilion Campus, Vermilion, Alberta. The collection list was entered in the electronic files of the Computing Services of the University of Alberta. The lists were set up in suitable columns so that the information could be sorted numerically and alphabetically at several levels by the publically available program called *SORT (Computing Services 1977). Columns were spaced and aligned with the TAB terminal device command. The columns were arranged as follows:

Columns 1 - 4	collection number
Columns 6 - 8	code for family
Columns 10 - 59	name of taxon
Columns 60 - 80	location code

Lines corresponding to each specimen were entered at random into the electronic file and were sorted at different column priorities, creating several inverted lists. In the *collection list* the sequence of entries is the same as in the field book that is, ranked according to the collection numbers. This arrangement is useful for entering further information from the field book. Data referring to collections, made at one site on the same day, were entered in one operation. Successive updates were merged with the collection list. The list arranged in taxonomic order followed Moss (1959). It was used for mapping purposes and for creating the list of taxa in the Appendix. Up-to-date site lists were another form of inverted lists. They were used in the later stages of the field work and in writing up the description of vegetation for this study. A modified form of the collection list was entered in a subfile of *SPIRES, the Stanford Public Information Retrieval System (Swartz and Jackson 1978), for the purposes of producing herbarium labels and for convenient retrieval of distributional and ecological data. No programming was involved in using the computer facilities but help was obtained from the consultants at the Computing Services of the University of Alberta and from user manuals (Computing Services 1977; Hogg and Tenisci 1978).

Location records for each species have been included in the distribution maps of the vascular plants of Alberta, compiled by Dr. J. G. Packer, based on specimens in the herbaria of the University of Alberta (ALTA), University of Calgary (UAC), University of Lethbridge (LEA), Canada Department of Agriculture (DAO) in Ottawa and the National Museum of Canada (CAN). These maps were kindly made available to me by Dr. J. G. Packer. The maps were examined for distribution patterns within Alberta and particularly within the study area. Each of the species were assigned to a phytogeographical category within the study area and within the North American continent. The bookkeeping and cross referencing was done with the help of the *SORT program under the Michigan Terminal System (Computing Services 1977).

Information regarding the North American distribution was obtained from various floras and articles. The following floras, listed in the order of importance for this study, were relied on most heavily: Hultén (1968), Hitchcock and Cronquist (1973), Scoggan (1957), Great Plains Flora Association (1977) and Booth and Wright (1966). The areal patterns were analyzed by comparing the distribution maps for each species. After they were classified and coded according to their distributional patterns, the species were cross-referenced and grouped by the computer program *SORT (Hogg and Tenisci 1978). Percentages of phytogeographical groups within the study area were based on all the 800 species found in or reported for the study area. Percentages for the Northern Hemisphere and North American groups were based on a total of 660 species for which distribution data could be found. Although this method of selection is, by necessity, arbitrary, the large number of species used give a reasonably accurate indication of the geographical affinities of the study area species.

RESULTS OF INVESTIGATIONS

First records and rare finds

Approximately 2400 specimens of vascular plants were collected from 51 localities exclusive of roadside collections. The above number does not include duplicate sheets bearing the same sample number. The following specimens were recorded for the first time for the study area: *Equisetum variegatum* Schleich., *Lemna trisulca* L., *Poa juncifolia* Scribn., *Nuphar variegatum* Engelm., *Caltha natans* Pall., *Viola palustris* L. and *Pedicularis groenlandica* Retz.

Species reported for the first time for the study area outside the Cypress Hills: *Picea glauca* (Moench) Voss, *Pyrola virens* Schweigg., *Hackelia americana* (A. Gray) Fern., *Scutellaria galericulata* L. Species reported for the first time for the parkland portion of the study area are: *Glyceria borealis* (Nash) Batchelder, *Glyceria striata* (Lam.) Hitchc., *Oryzopsis hymenoides* (R.& S.) Ricker, *Phalaris arundinaceae* L., *Schizachne purpurascense* (Torr.) Swallen, *Sporobolus cryptandrus* (Torr.) A. Gray, *Euphorbia serpyllifolia* Pers.

Second collections were made of *Muhlenbergia asperifolia* and *Lysimachia hybrida*. *Aristida longiseta*, described by Moss (1959) as "very rare", was also collected. The results of the field work are also reported in the section entitled

Description of Vegetation and the majority of the specimens are listed in the Appendix.

Geographical distributions within the study area

Widespread species

These species occur both in the aspen parkland and prairie. Most of them also have been reported from the Cypress Hills.

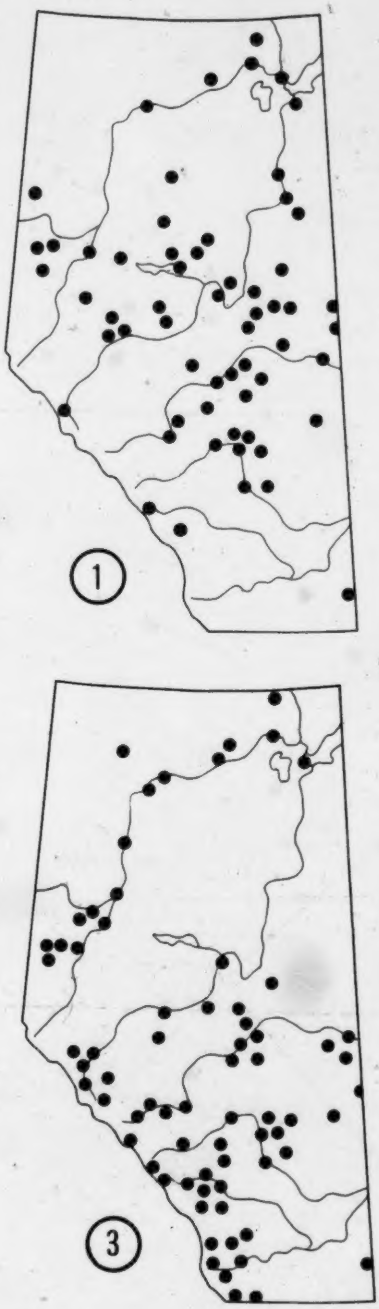
Of the total of 800 species counted for the study area, 248 species or 31% belong to this group.

Aspen parkland species

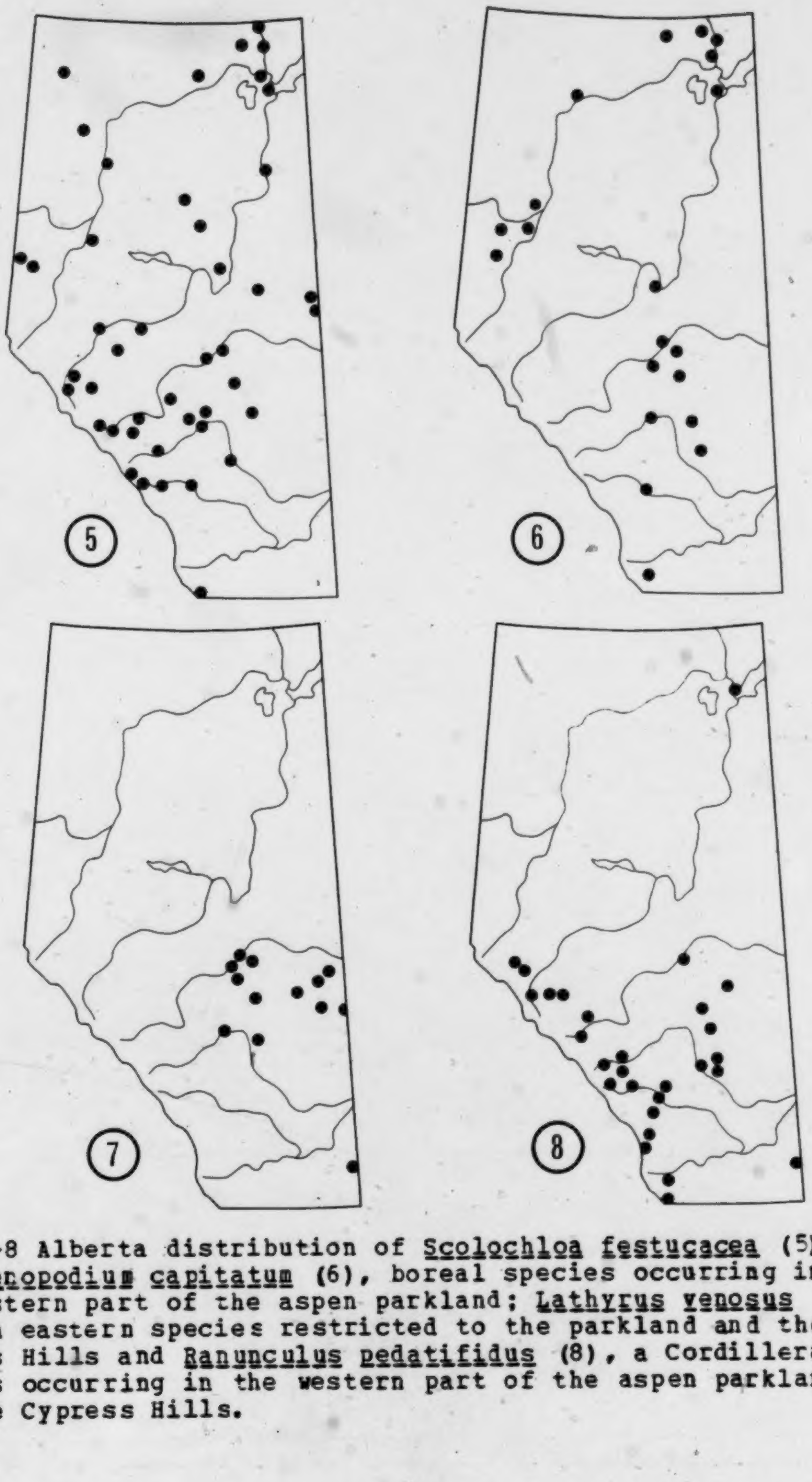
The total number of species counted for the aspen parkland is 425, but of these 228 are widespread throughout the study area and most of Alberta. 197 species, or 25% of the total for the study area, occur in the aspen parkland but are not found in the prairie (see maps 1-4).

Western aspen parkland species

50 of the aspen parkland species are found only in the western part of the parkland, reaching the 111°30' longitude as their eastern limit (Maps 5, 6 and 8). They are listed as follows:



Maps 1-4 Alberta distribution of *Aralia nudicaulis* (1) *Gentianella amarella* (2) *Erigeron glabellus* (3) and *Solidago decumbens* (4), boreal species occurring in the aspen parkland and Cypress Hills part of the study area.



Maps 5-8 Alberta distribution of *Scolochloa festucacea* (5) and *Chenopodium capitatum* (6), boreal species occurring in the western part of the aspen parkland; *Lathyrus venosus* (7), an eastern species restricted to the parkland and the Cypress Hills and *Ranunculus pedatifidus* (8), a Cordilleran species occurring in the western part of the aspen parkland and the Cypress Hills.

Antennaria corymbosa E. Nels.
Artemisia dranunculus L.
Aster brachyactis Blake
Aster ericoides L.
Aster pansus (Blake) Cronq.
Bromus inermis Leyss.
Bromus marginatus Nees
Calamagrostis neglecta (Ehrh.) Gaertn.
Carex peckii Howe
Carex rossii Boott
Carex rostrata Stokes
Carex scirpoidea Michx.
Carex simulata Mack.
Carex sprengelii Dewey
Carex torreyi Tuckerm.
Castilleja septentrionalis Lindl.
Catabrosa aquatica (L.) Beuv.
Chenopodium capitatum (L.) Aschers.
Cinna latifolia (Trev.) Griseb.
Dodecatheon conjugens Greene
Eleocharis pauciflora (Lightf.) Link
Elymus innovatus Beal
Epilobium leptophyllum Raf.
Festuca saximontana Rydb.
Glyceria pulchella (Nash) Hitchc.
Juncus alpinus Vill. var. *rariflorus* Hartm.
Juncus nodosus L.
Juniperus communis L.
Muhlenbergia racemosa (Michx.) BSP.
Oxycoccus microcarpus Turcz.
Pedicularis groenlandica Retz.
Pinus contorta Loudon var. *latifolia* Engelm.
Populus acuminata Rydb.
Potentilla gracilis Dougl. var. *flabelliformis* (Lehm.) Nutt.
Potentilla plattensis Nutt.
Ranunculus abortivus L.
Ranunculus pedatifidus J.E Smith
Ribes setosum Lindl.
Salix brachycarpa Nutt.
Salix planifolia Pursh
Smilacina racemosa (L.) Desf. var. *amplexicaulis* (Nutt.) S. Watts
Sphenopolis intermedia (Rydb.) Rydb.
Sphenopolis obtusata (Michx.) Scribn.
Stellaria calycantha (Ledeb.) Bong
Stellaria longifolia Muhl.
Stipa columbiana Macoun
Tofieldia glutinosa (Michx.) Pers.
Veronica scutellata L.
Viola nephrophila Greene
Viola palustris L.
Woodsia oregana D.C. Eat.

Prairie species

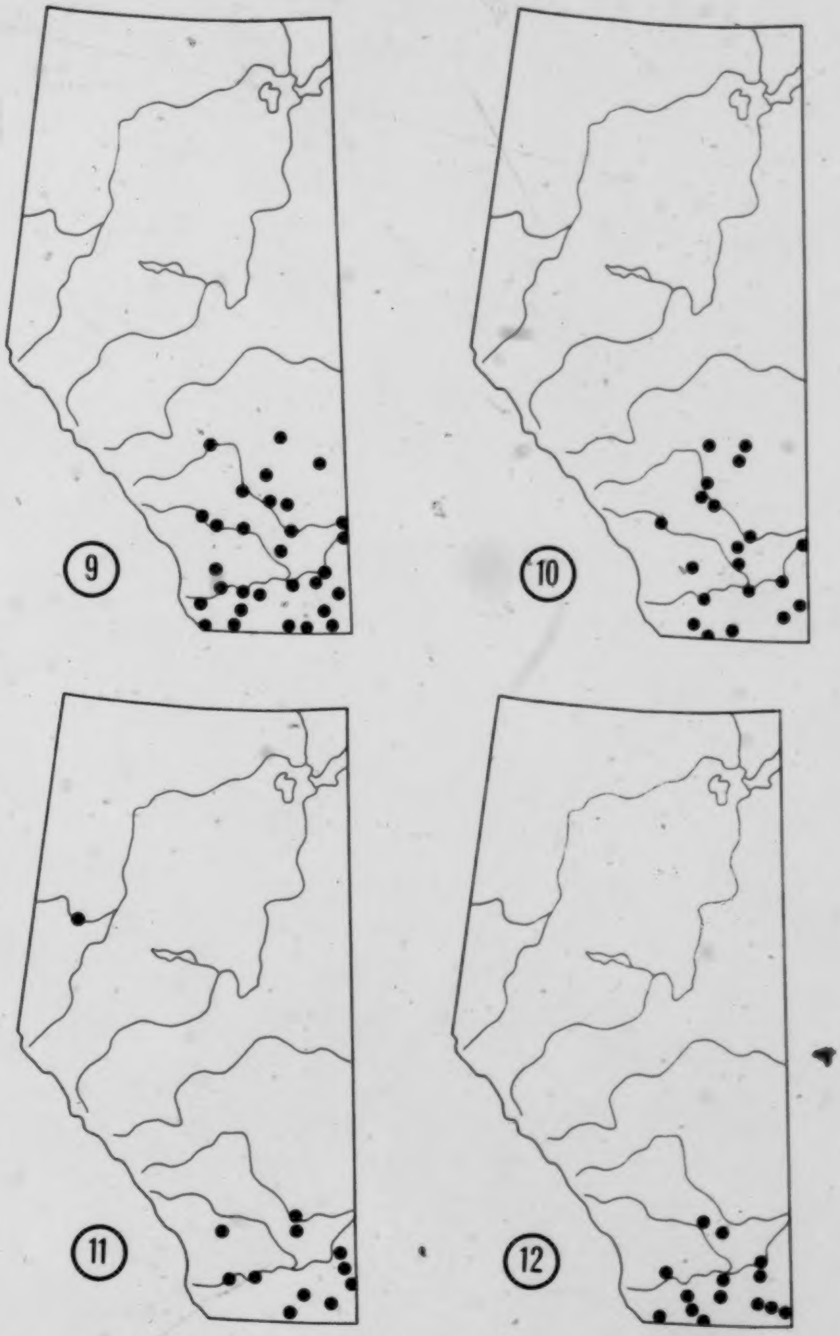
A total of 399 species are counted for the prairie. Of these 171 species, or 21% of the flora, are found in the prairie, but not in the aspen parkland (Map 9-12). 37 of the prairie species are also listed for the Cypress Hills.

31 species, or 4% of the total, are restricted to that corner of Alberta situated southeast of Medicine Hat. 17 species, or 2.1%, are found in the western part of the prairie, reaching the 111°30' longitude in the east. 24 species, or 3% of the flora, are restricted to the southern part of the prairie that is, south of the 50°30' latitude (see Maps 13 and 14).

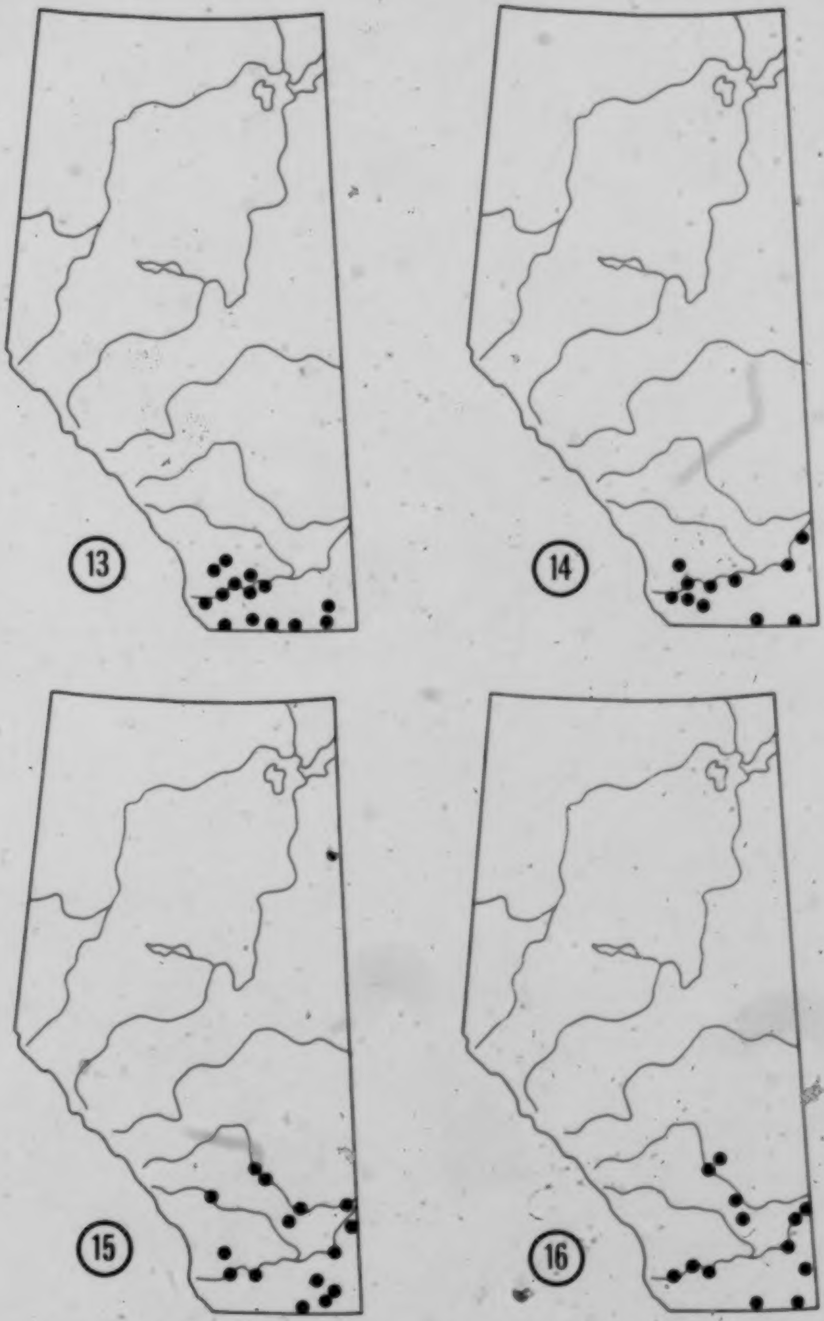
Species occurring in the Cypress Hills

The Cypress Hills flora is unusually diverse. Based on the distribution maps and the reports of Breitung (1954) and of de Vries and Bird (1968), a total of 369 species occur on the Alberta portion. Thus 44% of the flora of the study area is represented in an area which occupies only about 200 km² or 0.2% of the total.

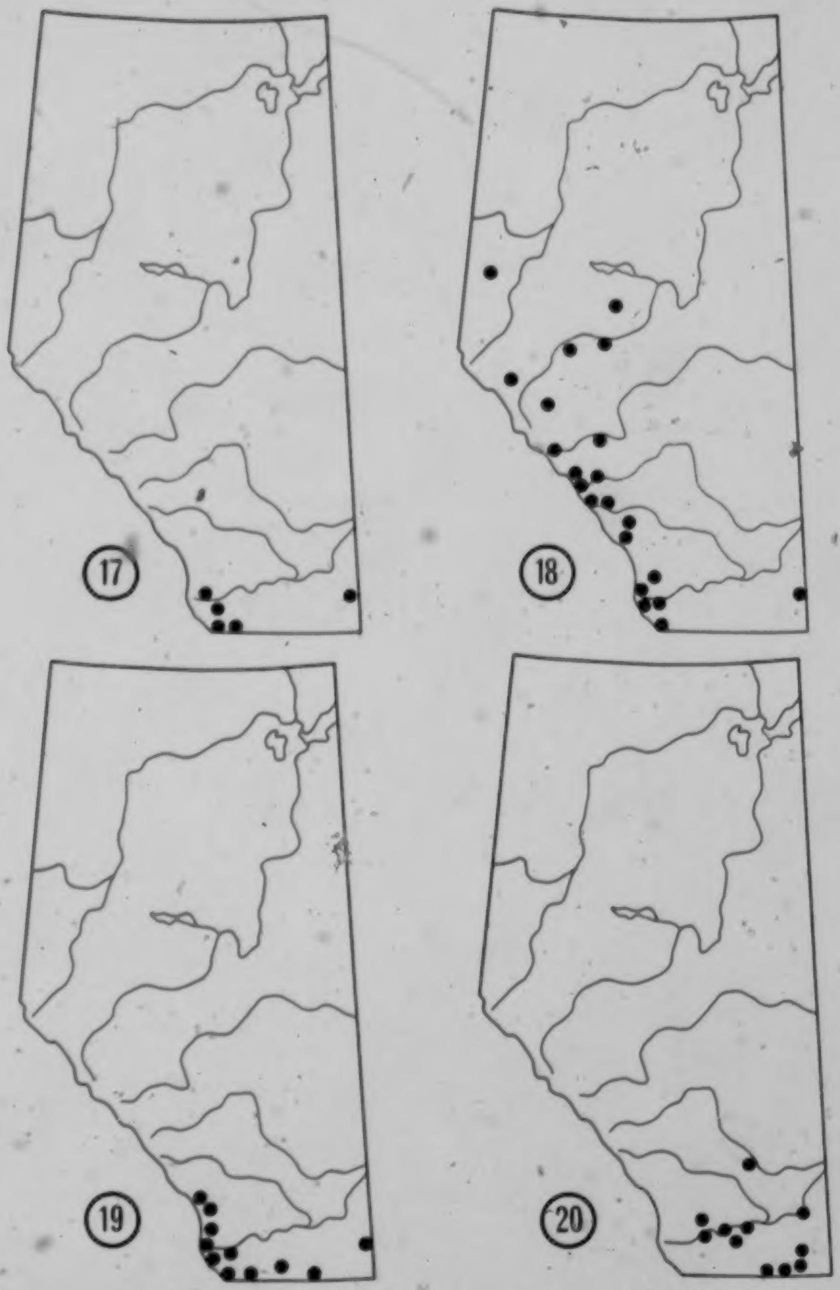
142 species or 38.5% of the flora are restricted to the Cypress Hills and do not occur in the rest of the study area (Map 17-19). 192 species, or 52% of the Cypress Hills flora,



Maps 9-12 Alberta distribution of four prairie species, *Ratibida columnifera* (9), *Artemisia cana* (10), *Atriplex argentea* (11) and *Myosorus minimus* (12).



Maps 13-16 Alberta distribution of two southern prairie species, *Hymenoxis acaulis* (13) and *Mentzelia decapetala* (14); and two prairie species, *Shepherdia argentea* (15) and *Opuntia polyacantha* (16).



Maps 17-20 Alberta distribution of *Polygonum bistortoides* (17) and *Thalictrum occidentale* (18), two Cordilleran species with disjunct populations in the Cyress Hills, *Heuchera parviflora* (19), a Cordilleran species restricted to the southwestern prairie and the Cypress Hills and *Juncus torrey* (20), a prairie species.

are present in the aspen parkland, and the remaining 10% is found both in the prairie and the Cypress Hills.

Geographical affinities of the study area species.

Of the 800 species reported to occur in the study area, the Northern Hemispheric distributions of 660 species were studied and the percentages below relate to this number.

I. *Circumpolar species*

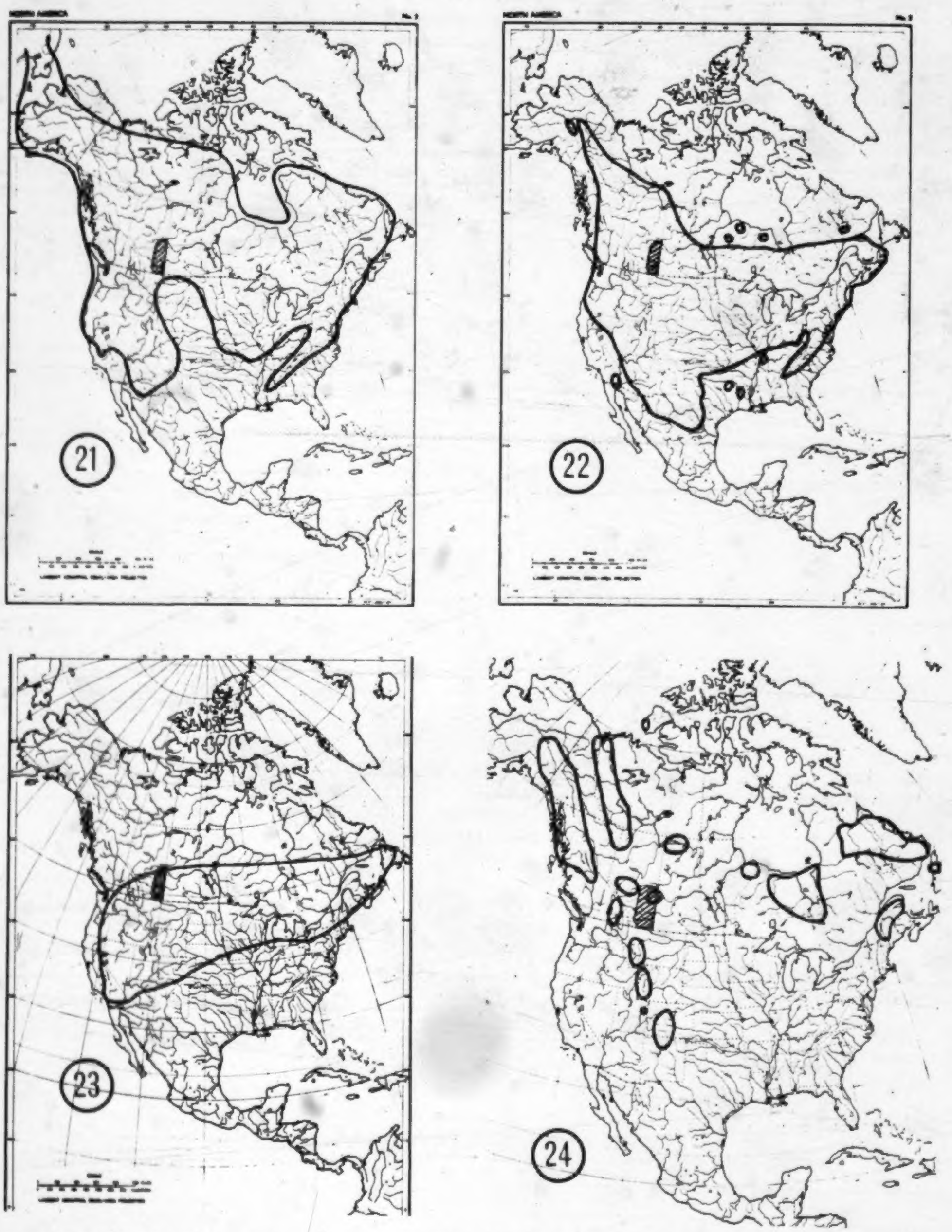
112 species or 17% of the species examined have a circumpolar range and are widely distributed in the Northern Hemisphere (see map 21).

Alopecurus aequalis Sobol.
Androsace septentrionalis L.
Arabis glabra (L.) Bernh.
Arctostaphylos uva-ursi (L.) Spreng.
Arenaria lateriflora L.
Arenaria rubella (Whalenb.) J. E. Sm.
Beckmania syzigachne (Steud.) Fern.
Botrychium multifidum (Gmel.) Rupr.
Botrychium virginianum (L.) Sw.
Bromus tectorum L.
Calamagrostis canadensis (Michx.) Beauv.
Calamagrostis neglecta (Ehrh.) Gaertn.
Callitriche hermaphroditica L.
Callitriche palustris L.
Calypso bulbosa (L.) Oakes
Campanula rotundifolia L.
Carex aquatilis Wahlenb.
Carex atherodes Spreng.
Carex capillaris L.
Carex diandra Schrank.
Carex disperma Dewey
Carex rostrata Stokes
Carex viridula Michx.
Ceratophyllum demersum L.
Chenopodium capitatum (L.) Aschers.
Chimaphila umbellata (L.) Bart. var. *occidentalis* (Rydb.) Blake
Cinna latifolia (Trev.) Griseb.
Circaea alpina L.
Corallorhiza trifida Chatelain

Cystopteris fragilis (L.) Bernh.
Deschampsia caespitosa (L.) Beauv.
Eleocharis acicularis (L.) R. & S.
Eleocharis palustris (L.) R. & S.
Eleocharis pauciflora (Lightf.) Link var. *fernaldii* Svenson
Epilobium angustifolium L.
Equisetum fluviatile L.
Equisetum hyemale L.
Equisetum palustre L.
Equisetum pratense Ehrh.
Equisetum scirpoides Michx.
Equisetum sylvaticum L.
Equisetum variegatum Schleich.
Eriophorium angustifolium Honckeny
Galium aparine L.
Galium boreale L.
Galium trifidum L.
Galium triflorum Michx.
Gentianella amarella (L.) Borner ssp. *acuta* (Michx.) JM.Gillet
Geum rivale L.
Glaux maritima L.
Glyceria grandis S. Wats.
Gnaphalium uliginosum L.
Habenaria viridis (L.) R. Br. var. *bracteata* (Muhl.)
Hieracium umbellatum L.
Hierochloe odorata (L.) Beauv.
Hippuris vulgaris L.
Juncus bufonius L.
Juniperus communis L.
Lemna minor L.
Lemna trisulca L.
Limosella aquatica L.
Listera cordata (L.) R. Br.
Luzula multiflora (Retz.) Lej.
Lycopodium annotinum L.
Lycopodium complanatum L.
Lysimachia thyrsifolia L.
Malaxis brachyopoda (A. Gray) Fern.
Mentha arvensis L.var. *villosa* (Benth.) S.R. Stewart
Monesis uniflora (L.) A. Gray
Myriophyllum exalbescens Fern.
Myriophyllum verticillatum L.
Parnassia palustris L. var. *neogaea* Fern.
Phalaris arundinacea L.
Poa palustris L.
Poa pratensis L.
Polygonum amphibium L. var. *stipulaceum* (Coleman)
Polygonum aviculare L.
Polygonum lapathifolium L.
Potamogeton filiformis Pers.
Potamogeton friesii Rupr.

Potamogeton gramineus L.
Potamogeton pectinatus L.
Potamogeton pusillus L.
Potentilla anserina L.
Potentilla fruticosa L.
Potentilla norvegica L.
Pyrola minor L.
Pyrola secunda L.
Pyrola virens Schweigg.
Ranunculus acris L.
Ranunculus aquatilis L. var. *capillaceus* (Thuill.) DC.
Ranunculus cymbalaria Pursh
Ranunculus sceleratus L.
Rhinanthus crista-galli L.
Rosa acicularis Lindl.
Ruppia occidentalis S. Wats.
Sparganium angustifolium Michx.
Spergularia marina (L.) Griseb. var. *leiosperma* (Kindb.) Gurke
Stachys palustris L. var. *pilosa* (Nutt.) Fern.
Stellaria crassifolia Ehrh.
Stellaria longifolia Muhl.
Stellaria longipes Goldie
Triglochin maritima L.
Triglochin palustris L.
Trisetum spicatum (L.) Richt.
Typha latifolia L.
Utricularia intermedia Hayne
Utricularia minor L.
Utricularia vulgaris L. var. *americana* A. Gray
Veronica scutellata L.
Viola palustris L.
Zannichellia palustris L.

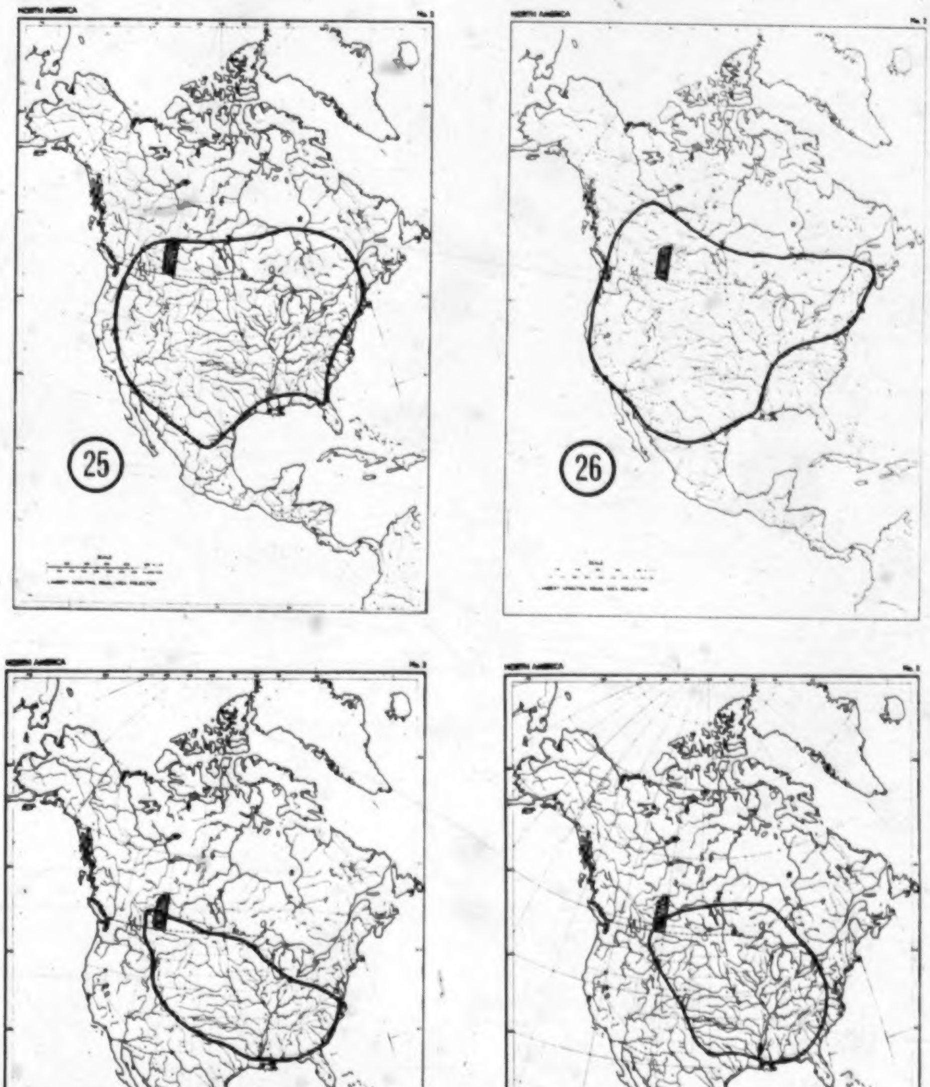
II. *Widespread boreal and temperate North American species*. 98 species or 15% of the species examined belong in this heterogeneous group. Their area ranges from the subarctic to the southern limit of the temperate zone. Many of these species correspond to what Porsild (1955) called North American radiants. Species which occur in Eurasia near the Atlantic and Pacific oceans, but which cannot be considered circumpolar, are also included in this group (see Maps 22 and 23).



Maps 21-24 North American distribution of *Calamagrostis canadensis* (21), a circumpolar species - Category I., *Apocynum androsaemifolium* (22) and *Alisma plantago-aquatica* (23), species widespread in boreal and temperate North America - Categ. II., and *Astragalus eucosmus* (24), a northern species (Categ. III.) with a broken range and outliers in the Rocky Mountains.

Achillea millefolium L. ssp. *lanulosa* (Nutt.) Piper
Anaphalis margaritacea (L.) Benth. & Hook.
Apocynum androsaemifolium L.
Apocynum sibiricum Jacq.
Aralia nudicaulis L.
Artemesia biennis Willd.
Astragalus aboriginum Richards.
Bromus ciliatus L.
Calamagrostis inexpansa A. Gray
Carex aurea Nutt.
Carex bebbii Olney
Carex concinna R. Br.
Carex deweyana Schwein.
Carex foena Willd.
Carex lasiocapa Ehrh. var. *americana*
Carex praticola Rydb.
Catabrosa aquatica (L.) Beauv.
Cerastium arvense L.
Chenopodium leptophyllum Nutt.
Chenopodium rubrum L. var. *humile* (Hook.) S. Wats.
Collomia linearis Nutt.
Corallorhiza maculata Raf.
Corispermum orientale Lam. var. *emarginatum* (Rydb.)
Cornus stolonifera Michx.
Corydalis aurea Willd.
Corylus cornuta Marsh.
Crepis occidentalis Nutt.
Cyperus inflexus Muhl.
Epilobium alpinum L.
Epilobium glandulosum Lehm.
Festuca saximontana Rydb.
Geocaulon lividum (Richards.) Fern.
Geranium bricknelli Britt.
Geum allepicum Jacq. var. *strictum* (Ait.) Fern.
Geum triflorum Pursh
Glyceria borealis (Nash) Batchelder
Glyceria striata (Lam.) Hitch.
Habenaria hyperborea (L.) R. Br.
Helenium automnale L.
Juncus nodosus L.
Lepidium densiflorum Schrad.
Linnaea borealis L. var. *americana* (Forbes) Rehd.
Listera borealis Morong
Lonicera dioica L. var. *glaucescens* (Rydb.) Butters
Lycopus americanus Muhl.
Madia glomerata Hook.
Muhlenbergia racemosa (Michx.) BSP.
Muhlenbergia richardsonis (Trin.) Rydb.
Orchis rotundifolia Banks
Pedicularis groenlandica Retz.
Plantago eriopoda Torr.
Polygala senega L.
Polygonum achoreum Blake

Polygonum coccineum Muhl.
Polygonum ramosissimum Michx.
Potamogeton richardsonii (Benn.) Rydb.
Potentilla paradoxa Nutt.
Potentilla pensylvanica L.
Prunus pensylvanica L.f.
Prunus virginiana L.
Pyrola asarfolia Michx.
Pyrola elliptica Nutt.
Ranunculus abortivus L.
Ranunculus gmelinii DC.
Ranunculus pedatifidus J.E. Smith var. *affinis* (R. Br.) L. Benson
Rhus radicans L. var. *rydbergii* (Small) Rehder
Rorippa islandica (Oeder) Borbas
Sagittaria cuneata Sheld.
Salix brachycarpa Nutt.
Salix candida Fluegge
Salix discolor Muhl.
Salix myrtillifolia Anderss.
Salix petiolaris J. E. Sm.
Sanicula marilandica L.
Schizachne purpurascens (Torr.) Swallen
Scirpus acutus Muhl.
Scirpus validus Vahl
Senecio pauperculus Michx.
Senecio pseudaureus Rydb.
Shepherdia canadensis (L.) Nutt.
Sisyrinchium montanum Greene
Smilacina racemosa (L.) Desf. var. *amplexicaulis* (Nutt.) S. Wats.
Smilacina stellata (L.) Desf.
Solidago gigantea Ait.
Solidago graminifolia (L.) Salisb.
Sparganium multipedunculatum (Morong) Rydb.
Sphenopolis intermedia (Rydb.) Rydb.
Spiranthes romanzoffiana Cham. & Schl.
Streptopus amplexifolius (L.) DC.
Symphoricarpos albus (L.) Blake
Thalictrum venulosum Trel.
Tofieldia glutinosa (Michx.) Pers.
Urtica gracilis Ait.
Vaccinium caespitosum Michx.
Verbena bracteata Lag. & Rodr.
Vicia americana Muhl.
Viola adunca J.E. Smith
Viola renifolia A. Gray
Zizia aptera (A. Gray) Fern.



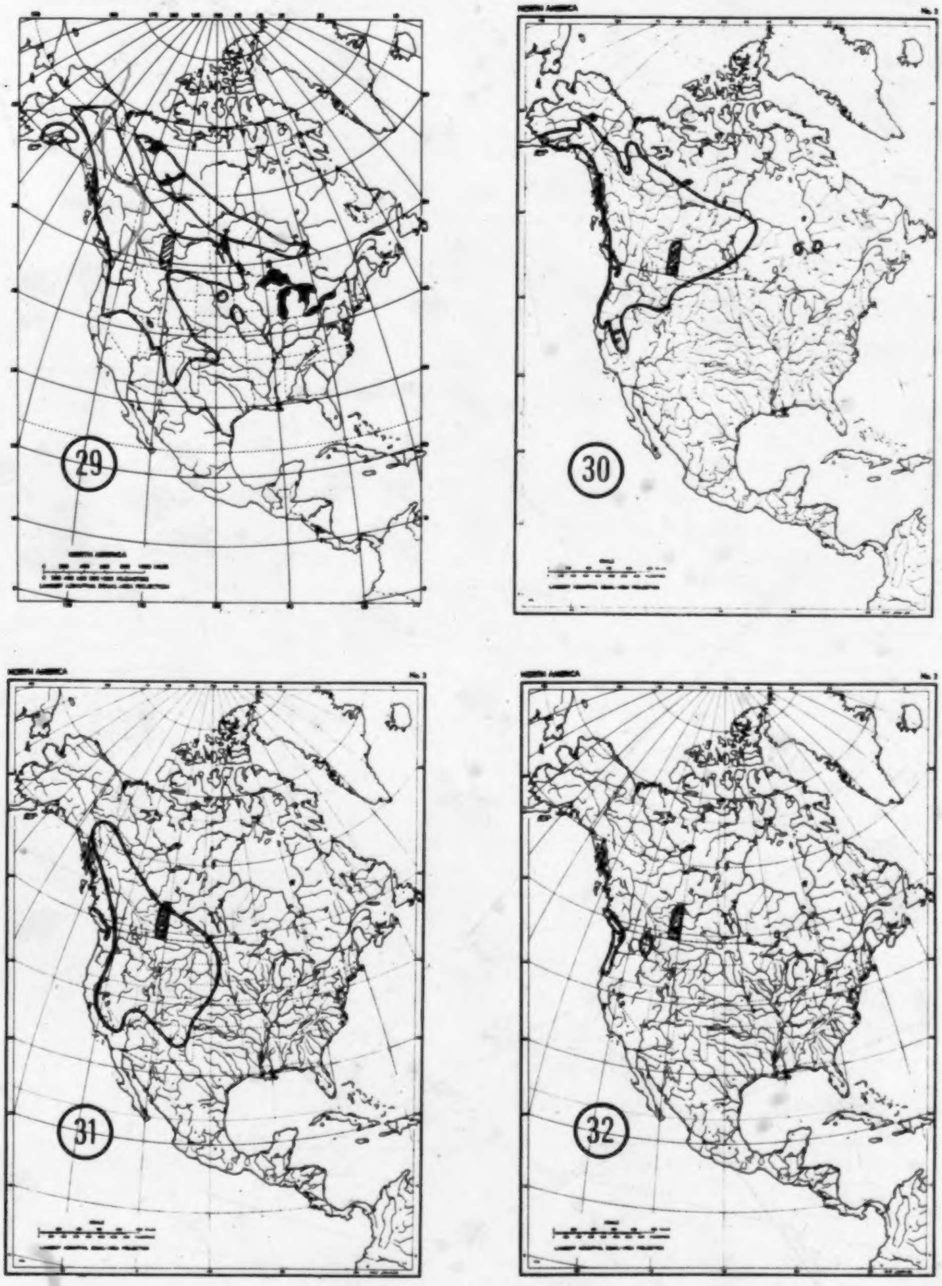
Maps 25-28 North American distribution of *Festuca octoflora* (25) and *Koeleria cristata* (26), species widespread in south-temperate North America - Categ. IV., and *Petalostemon candidum* (27) and *Hedeoma hispida* (28), two eastern species (Categ. V.).

III. *Northern species*.

These are subarctic and boreal species (Scoggan 1957) occupying an area from Alaska southeast to the south shore of the Hudson Bay, and then east and north to Labrador. Their southern limit is usually the north shore of the Great Lakes in eastern Canada, and approximately the 49th parallel in the west, except for a lobe reaching south in the Rocky Mountains.

The northern species number 22 and make up 3.3% of the flora. (see map 24.).

Agastache foeniculum (Pursh) Ktze.
Antennaria pulcherrima (Hook.) Greene
Aster ciliolatus Lindl.
Astragalus eucosmus Robins.
Carex scirpiformis Mack.
Eleagnus commutata Bernh.
Elymus innovatus Beal
Habenaria obtusata (Pursh) Richards.
Hedysarum alpinum L.
Juniperus horizontalis Moench
Maianthemum canadense Desf. var. *interius* Fern
Petasites vitifolius Greene
Picea glauca (Moench) Voss
Populus balsamifera L.
Ranunculus circinatus Sibth. var. *subrigidus* (W. Drew) L. Benson
Ranunculus flammula L.
Ranunculus macounii Britt.
Ribes lacustre (Pers.) Poir.
Rubus acaulis Michx.
Rubus strigosus Michx.
Salix interior Rowlee
Viburnum edule (Michx.) Raf.



Maps 29-32 North American distribution of *Amelanchier alnifolia* (29), *Antennaria rosea* (30), *Poa secunda* (31) and *Psilocarpus eliator* (32), western American species (Categ. VI.).

IV. *South-temperate American species*.

The northern limit of this group is approximately the 50th parallel in the prairie provinces, though some species may reach further north in eastern and western Canada. Their southern boundary ranges from the 40th parallel to Central America.

31 species belong in this group, comprising 4.6% of the flora. (See Maps 25 and 26.).

Allium cernuum Roth
Amaranthus albus L.
Aster laevis L. var *geyeri* A. Gray
Carex interior Bailey
Chenopodium berlandieri Moq. var. *farinosum* (Ludw
Chenopodium glaucum L. ssp. *salinum* (Standl.) Aellen
Chenopodium hybridum L.
Chenopodium pratericola Rydb.
Corallorhiza striata Lindl.
Ellisia nyctela L.
Equisetum laevigatum A. Br.
Euphorbia glyrtosperma Engelm.
Festuca octoflora Walt.
Gentianella crinata (Froel.) G.Don *macounii* (Holm)
J.M. Gillett
Gratiola neglecta Torr.
Iva axillaris Pursh
Koeleria cristata (L.) Pers.
Lactuca pulchella (Pursh) DC.
Lysimachia ciliata L.
Lysimachia hybrida Michx.
Myosorus minimus L.
Osmorhiza longistylis (Torr.) DC.
Parietaria pensylvanica Muhl.
Phleum alpinum L.
Populus sargentii Dode
Salix amygdaloides Anderss.
Scirpus americanus Pers.
Solidago rigida L. var. *humilis* Porter
Sphenopolis obtusata (Michx.) Scribn.
Sporobolus cryptandrus (Torr.) A. Gray
Xanthium strumarium L.

V. *Eastern American species*.

19 species or 3% of the total reach Alberta from eastern North America. (See Maps 27 and 28.).

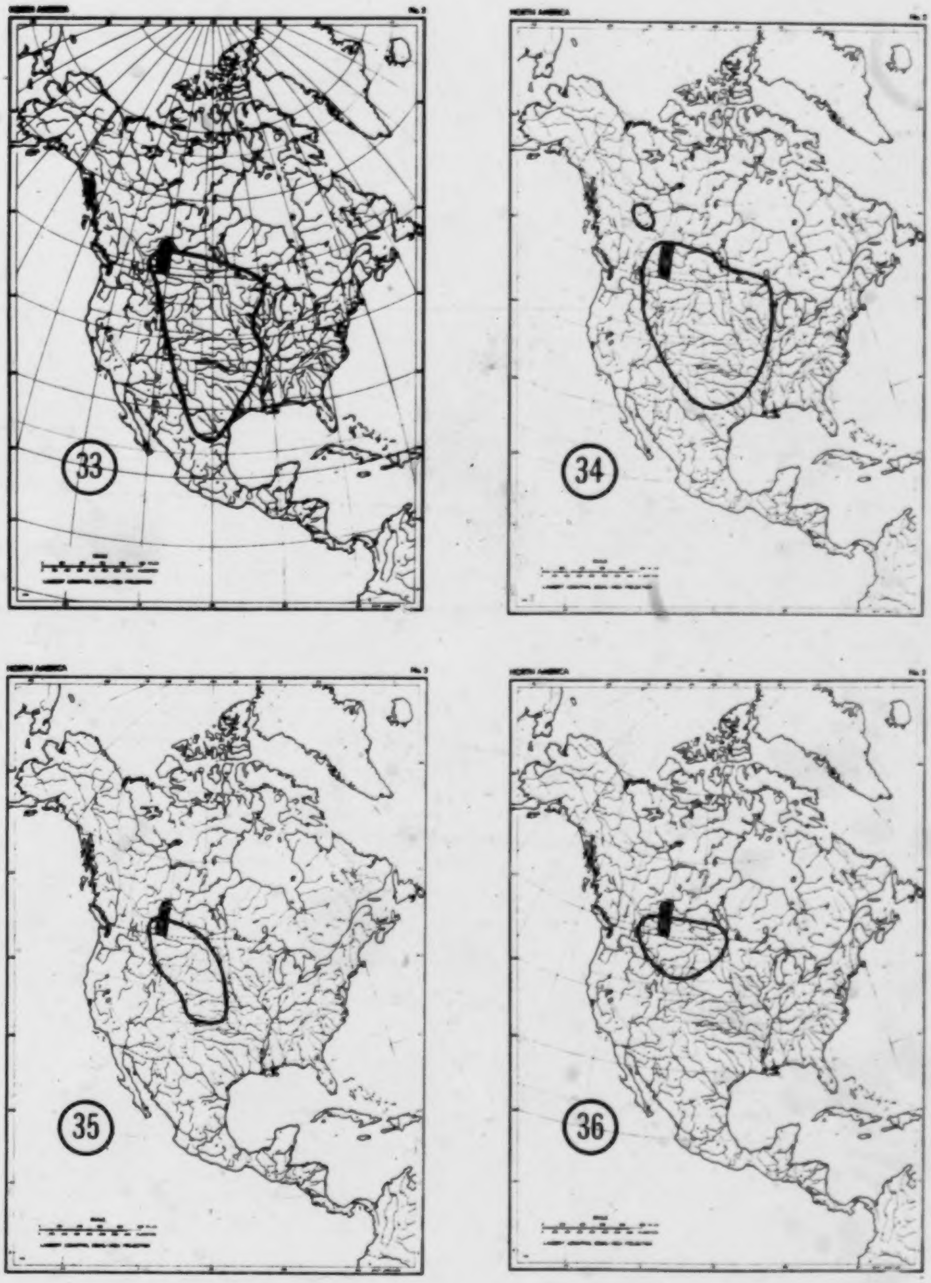
Agrimonia striata Michx.
Ambrosia artemisiifolia L. var. *elatior* (L.) Descourtils
Ambrosia psilostachya DC. var *coronopifolia* (T. & G.) Farw.
Anemone canadensis L.
Atriplex patula var. *hastata* (L.) A. Gray
Carex brevior (Dewey) Mack.
Carex lacustris Willd.
Crataegus chrysocarpa Ashe
Danthonia spicata (L.) Beauv.
Elymus virginicus L.
Euphorbia serpyllifolia Pers.
Lathyrus ochroleucus Hook.
Lobelia kalmii L.
Nuphar variegatum Engelm
Oenothera biennis L.
Oryzopsis asperifolia Michx.
Ribes americanum Mill.
Salix serissima (Bailey) Fern.
Spirea alba Du Roi

VI. *Western American species*.

This well-defined group includes 128 species or 19% of the660 species examined. Typically the area of these species stretches from Alaska south south-east, parallel with the Rocky Mountains, often as far as New Mexico. Their eastern limit is Manitoba. They may or may not reach the West Coast.

Many of these species are montane and the influence of the Rocky Mountains is clearly discernible in their geographical distribution. (See maps 29-32).

Actaea rubra (Ait.) Willd.
Agropyron smithii Rydb.
Agropyron subsecundum (Link) Hitchc.
Agrostis exarata Trin.



Maps 33-36 North American distribution of *Liatris punctata* (33), *Penstemon gracilis* (34), *Astragalus pectinatus* (35) and *Penstemon nitidus* (36), southern or Great Plains species (Categ. VII.).

Agrostis scabra Willd.
Alisma gramineum K. C. Gmel.
Alisma plantago-aquatica L.
Alnus tenuifolia Nutt.
Amelanchier alnifolia Nutt.
Anemone multifida Poir
Antennaria neglecta Greene
Antennaria nitida Greene
Antennaria rosea Greene
Arabis divaricarpa A. Nels.
Arabis drummondii A. Gray
Arabis hirsuta (L.) Scop. var. *pycnocarpa* (Hopkins) Rollins
Arabis holboellii Hornem.
Arnica chamissonis Less.
Artemesia frigida Willd.
Artemesia ludoviciana Nutt.
Artemsia dranunculus L.
Aster canescens Pursh
Aster falcatus Lindl.
Aster hesperius A. Gray
Astragalus agrestis Dougl.
Astragalus canadensis L.
Astragalus frigidus (L.) A. Gray var. *americanus* (Hook.) Wats.
Astragalus tenellus Pursh
Bromus breviaristatus (Hook.) Buckl.
Bromus carinatus H. & A.
Bromus inermis Leiss.
Bromus marginatus Nees
Bromus purgans L.
Calamagrostis purpurascens R. Br.
Carex arthrostachya Olney
Carex filifolia Nutt.
Carex microptera Mack.
Carex obtusata Lilj.
Carex pachystachya Cham.
Carex platylepis Mack.
Carex praegracilis W. Boott
Carex rossii Boott
Carex sychnocephala Carey
Castilleja miniata Dougl.
Cicuta douglasii (DC.) Coult. & Rose
Collinsia parviflora Dougl.
Crataegus douglasii Lindl.
Crepis runcinata (James) T. & G.
Danthonia intermedia Vasey
Descurainia pinnata (Walt.) Britt. var. *brachycarpa* (Walt.) Britt.
Descurainia richardsonii (Sweet) O.E. Schulz
Dodecatheon radicatum Greene
Dracocephalum nuttallii Britt.
Elatine triandra Schk.

Elymus glaucus Buckl.
Elymus macounii Vasey
Epilobium paniculatum Nutt.
Erigeron caespitosus Nutt.
Erigeron compositus Pursh
Erigeron lonchophyllus Hook.
Erigeron pumilus Nutt.
Erigeron subtrinervis Rydb. var. *conspicuus* (Rydb.) Cronq.
Festuca scabrella Torr.
Fragaria virginiana Duchesne
Geranium richardsonii Fisch. & Trautv.
Geum macrophyllum Willd.
Glyceria pulchella (Nash) K. Schum.
Glycyrrhiza lepidota (Nutt.) Pursh
Hackelia americana (A. Gray) Fern.
Helianthus annuus L. ssp. *lenticularis* (Dougl.) Cockerell
Helianthus nuttallii T. & G.
Hymenopappus filifolius Hook.
Juncus ensifolius Wikstr.
Linum lewisii Pursh
Lychnis drummondii (Hook.) S. Wats.
Mertensia paniculata (Ait.) G. Don
Mimulus guttatus DC.
Oenothera nuttallii Sweet
Oryzopsis hymenoides (R. & S.) Ricker
Osmorhiza depauperata Philippi
Osmorhiza purpurea (Coult. & Rose) Suksd.
Oxytropis campestris (L.) DC.
Oxytropis deflexa (Pall.) DC.
Pedicularis bracteosa Benth.
Penstemon confertus Dougl.
Penstemon procerus Dougl.
Pinus contorta var. *latifolia* Engelm.
Poa canbyi (Scribn.) Piper
Poa cusickii Vasey
Poa interior Rydb.
Poa secunda Presl
Potentilla bipinnatifida Dougl.
Potentilla diversifolia Lehm.
Potentilla finitima Kohli & Packer
Potentilla gracilis Dougl. var. *pulcherrima* (Lehm.) Fern.
Potentilla gracilis Dougl var. *rigida* (Nutt.) S. Wats.
Primula incana M.E. Jones.
Psilocarpus eliator A. Gray
Puccinellia nuttalliana (Schult.) Hitchc.
Ranunculus cardiophyllus Hook.
Ranunculus rhomboideus Goldie
Ribes hudsonianum Richards
Ribes oxyacanthoides L.
Rorippa obtusata (Nutt.) Britt.

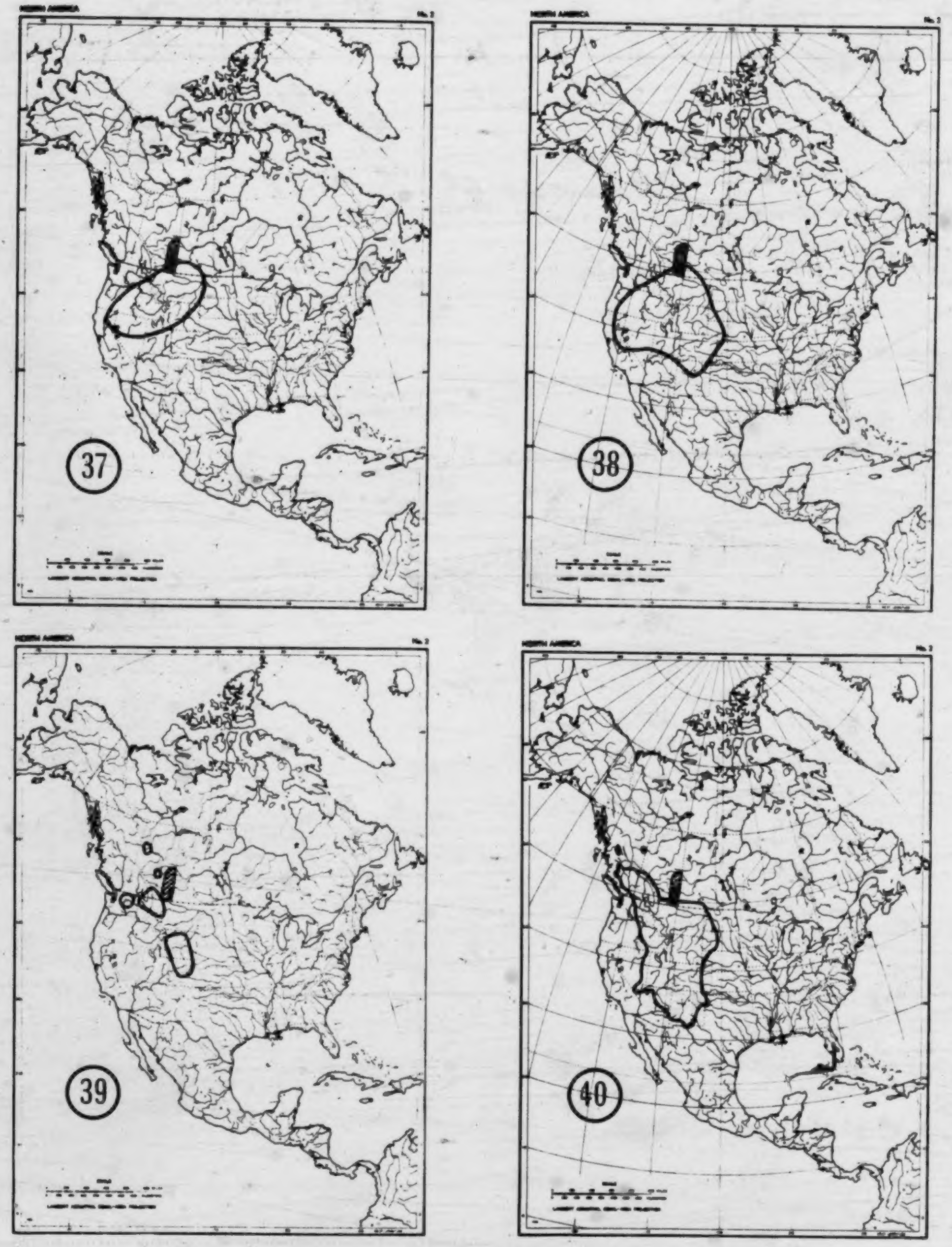
Rorippa sinuata (Nutt.) Hitchc.
Rumex mexicanus Meisn.
Salix lutea Nutt.
Salix pseudomonticola Ball
Salix scouleriana Barratt
Scirpus microcarpus Presl
Scirpus paludosus A. Nels.
Scolochloa festucacea (Willd.) Link
Scutellaria galericulata L.
Sedum stenopetalum Pursh
Senecio canus Hook.
Senecio eremophilus Richards.
Silene menziesii Hook.
Solidago decumbens Greene
Solidago lepida DC.
Spirea lucida Dougl.
Stipa columbiana Macoun
Suaeda depressa (Pursh.) S. Wats.
Thalictrum occidentale A. Gray
Townsendia parryi D. C. Eat.
Vaccinium myrtilloides Michx.
Veronica serpyllifolia L.var. humifusa (Dickson) Vahl
Viola rugulosa Greene
Zygadenus elegans Pursh

VII. Southern or Great Plains species.

115 species, or 17% of the species examined occupy areas that are generally oval in shape oriented in a north-south direction. The range of some species may extend from southern Alberta as far south as New Mexico, and from the Rocky Mountains to Iowa.

None of the "Great Plains" species are restricted to the plains. Their range extends into the Rocky Mountains. (See maps 33-36).

Abronia micrantha Torr.
Agropyron dasystachyum (Hook.) Scribn.
Agropyron riparium Scribn. & Smith
Allium textile Nels. & Macbr.
Ambrosia trifida L.
Antennaria parviflora Nutt.



Maps 37-40 North American distribution of *Oenothera brevifolia* (37), *Eriogonum cernuum* (38), two southwestern species - (Categ. VIII.) and *Polygonum douglasii* (39) and *Juniprus scopulorum* (40), two Cordilleran species - (Categ. IX.)

Aristida longiseta Steud.
Arnica fulgens Pursh
Artemesia longifolia Nutt.
Asclepias ovalifolia Dene.
Asclepias viridiflora Raf.
Aster pauciflorus Nutt.
Astragalus bisulcatus (Hook.) A. Gray
Astragalus caespitosus (Nutt.) A. Gray
Astragalus crassicarpus Nutt.
Astragalus drummondii Dougl.
Astragalus flexuosus Dougl.
Astragalus lotiflorus Hook.
Astragalus pectinatus (Hook.) Dougl.
Astragalus striatus Nutt.
Astragalus triphyllus Pursh
Astragalus vexilliflexus Sheld.
Atriplex powellii Wats.
Atriplex truncata (Torr.) Gray
Bouteloua gracilis (HBK.) Lag.
Bromus anomalus Rupr.
Calamagrostis montanensis Scribn.
Calamovilfa longifolia (Hook.) Scribn
Carex eleocharis Bailey
Carex heliophila Mack.
Carex nebraskensis Dewey
Carex torreyi Tuckerm.
Carex xerantica Bailey
Castilleja sessiliflora Pursh
Centunculus minimus L.
Chrysopsis villosa (Pursh) Nutt.
Cirsium flodmanii (Rydb.) Arthur
Cirsium undulatum (Nutt.) Spreng.
Coreopsis tinctoria Nutt.
Cryptandra bradburiana Payson
Cryptandra fendleri (A. Gray) Greene
Cymopterus acaulis (Pursh) Raf.
Cyperus schweinitzii Torr.
Eriogonum flavum Nutt.
Gaillardia aristata Pursh
Gutierrezia sarothrae (Pursh) Britt. & Rusby
Haplopappus nuttallii T. & G.
Hedeoma hispida Pursh
Hedysarum boreale Nutt.
Helianthus maximiliani Schrad.
Helictotrichon hookeri (Scribn.) Henr.
Heuchera richardsonii R. Br.
Hymenoxis acaulis (Pursh) Parker
Hymenoxis richardsonii (Hook.) Cockerell
Iva xanthifolia Nutt.
Lesquerella alpina (Nutt.) S. Wats. var. *spathulata*
    (Rydb.) Payson
Lesquerella arenosa (Richards.) Rydb.
Liatris ligulistylis (A. Nels.) K. Schum.

Liatris punctata Hook.
Lilium philadelphicum L. var. *andinum* (Nutt.) Ker
Linanthus septentrionalis H.L. Mason
Linum rigidum Pursh
Lithospermum incisum Lehm.
Lomatium foeniculaceum (Nutt.) Coult. & Rose
Lomatium simplex (Nutt) Macbr var *leptophyllum* (Hook)
Mathias
Lygodesmia juncea (Pursh) D. Don
Lygodesmia rostrata A. Gray
Mamillaria vivipara (Nutt.) Haw.
Marsilea mucronata A. Br.
Mentzelia decapetala (Pursh) Urban & Gilg
Mirabilis hirsuta (Pursh.) MacM.
Monarda fistulosa L.var. *menthaefolia* (Graham) Fern.
Muhlenbergia cuspidata (Torr.) Rydb.
Musineon divaricatum (Pursh) Nitt. var. *hookeri* T. & G.
Oenothera serrulata Nutt.
Opuntia fragilis (Nutt.) Haw.
Opuntia polyacantha Haw.
Orobanche ludoviciana Nutt.
Paronchia sessiliflora Nutt.
Penstemon albidus Nutt.
Penstemon gracilis Nutt.
Penstemon nitidus Dougl.
Petalostemon candidum (Willd.) Michx.
Petalostemon purpureum (Vent.) Rydb.
Poa arida Vasey
Poa glaucifolia Scribn. & Will.
Populus acuminata Rydb.
Potentilla cocinna Richards.
Potentilla effusa Dougl.
Psoralea argophylla Pursh
Psoralea esculenta Pursh
Ratibida cclumnifera (Nutt.) Wooton & Standl.
Rhus trilobata Nutt.
Ribes setosum Lindl.
Rosa arkansana Porter
Saxifraga occidentalis S. Wats.
Scirpus nevadensis S. Wats.
Senecio integerrimus Nutt. var. *exaltatus* (Nutt.) Cronq.
Shepherdia argentea Nutt.
Solidago mollis Bartl.
Solidago pruinosa Greene
Sphaeralcea coccinea (Pursh) Rydb.
Sporobolus neglectus Nash
Stipa spartea Trin. var. *curtiseta* Hitchc.
Stipa viridula Trin.
Suckleya suckleyana (Torr.) Rydb.
Symphoricarpos occidentalis Hook.
Thermopsis rhombifolia (Nutt.) Richards
Vicia sparsifolia Nutt.
Viola nuttallii Pursh

Yucca glauca Nutt.

VIII. *Southwestern species*.

98 species or 15% of the species examined extend their range from the southern part of the Prairie Provinces to Nevada and California. Many of these species are montane. (See Maps 37 - 38.).

- *Agropyron albicans* Scribn. & Smith
- *Agropyron inerme* (Scribn. & Smith) Rydb
- *Agropyron spicatum* (Pursh) Scribn. & Smith
- *Androsace occidentalis* Pursh
- *Anemone cylindrica* A. Gray
- *Antennaria anaphalodes*
- *Antennaria corymbosa* E. Nels.
- *Antennaria dimorpha* (Nutt.) T.& G.
- *Arceuthobium americanum* Nutt.
- *Arnica sororia* Greene
- *Artemesia cana* Push
- *Asclepias speciosa* Torr.
- *Aster adscendens* Lindl.
- *Aster pansus* (Blake) Cronq.
- *Astragalus kentrophyta* A. Gray
- *Astragalus missouriensis* Nutt.
- *Astragalus purshii* Dougl.
- *Atriplex argentea* Nutt.
- *Atriplex nuttallii* S. Wats.
- *Boisduvalia glabella* (Nutt.) Walp.
- *Calamagrostis rubescens* Buckl.
- *Carex douglasii* Boott
- *Carex festivella* Mack.
- *Carex simulata* Mack.
- *Chenopodium fremontii* S. Wats.
- *Chrysothamnus nauseosus* (Pall.) Britt.
- *Claytonia lanceolata* Pursh
- *Clematis ligusticifolia* Nutt.
- *Clematis verticillaris* DC. var. *columbiana* (Nutt.) A. Gray
- *Cleome serrulata* Pursh
- *Comandra pallida* A. DC.
- *Cryptantha macounii* (Eastw.) Payson
- *Danthonia californica* Boland var. *americana* (Scribn.) Hitchc.
- *Delphinium bicolor* Nutt.
- *Distichlis stricta* (Torr.) Rydb.
- *Dodecatheon conjugens* Greene
- *Downingia laeta* Greene

Elymus cinereus Scribn. & Merr.
Eriogonum cernuum Nutt.
Erysimum asperum (Nutt.) DC.
Eurotia lanata (Pursh) Moq.
Festuca idahoensis Elmer
Franseria acanthicarpa (Hook.) Coville
Gaura coccinea Pursh
Gentiana affinis Griseb.
Geranium viscosissimum Fisch. & Mey.
Haplopappus lanceolatus (Hook.) T. & G.
Haplopappus spinulosus (Pursh) DC.
Heuchera cylindrica Dougl.
Juncus longistylis Torr.
Lappula redowskii (Hornem.) Greene var. *occidentalis* (Wats.) Rydb.
Lilaea scillioides (Poir.) Haum.
Lithospermum ruderale Lehm.
Lomatium cous (Wats.) Coult. & Rose
Lomatium macrocarpum (Hook. & Arn.) Coult. & Rose
Lomatium triternatum (Pursh) Coult. & Rose
Lupinus pusillus Pursh
Lupinus sericeus Pursh
Lycopus asper Greene.
Monolepis nuttalliana (Schultes) Greene
Montia linearis (Dougl.) Greene
Muhlenbergia asperifolia (Nees & Mey.) Parodi
Munroa squarrosa (Nutt.) Torr.
Myosorus aristatus Benth. ssp. *montanus* (Campbell) Stone
Navarretia minima Nutt.
Oenothera andina Nutt
Oenothera brevifolia (Nutt.) T. & G.
Oenothera caespitosa Nutt.
Oenothera flava (A. Nels.) Garrett
Orthocarpus luteus Nutt.
Perideridia gairdneri (Hook. & Arn.) Mathias
Phlox hoodii Richards.
Plantago elongata Pursh
Poa juncifolia Scribn.
Poa nervosa (Hook.) Vasey
Polanisia trachysperma T. & G.
Polygonum bistortoides Pursh
Polygonum douglasii Greene
Polygonum watsonii Small
Potentilla gracilis Dougl.
Potentilla plattensis Nutt.
Psoralea lanceolata Pursh
Pterospora andromeda Nutt.
Puccinellia cusickii Weath
Ranunculus glaberrimus Hook.
Ribes aureum Pursh
Rumex venosus Pursh
Salicornia rubra A. Nels.
Sarcobatus vermiculatus (Hook.) Torr.

Schedonnardus paniculatus (Nutt.) Trel.
Selaginella densa Rydb.
Senecio hydrophiloides Rydb.
Sitanion hystrix (Nutt.) J.G. Smith
Solanum triflorum Nutt.
Spartina gracilis Trin.
Stipa comata Trin. & Rupr.
Trisetum wolfii Vasey
Zygadenus gramineus Rydb.

IX. *Cordilleran species*.

Based on the reports of Breitung (1954) and de Vries and Bird (1968), 37 Cordilleran species were counted from the Alberta side of the Cypress Hills, comprising 10.2% of the vascular flora there. (See Maps 39 and 40.).

Antennaria corymbosa E. Nels.
Aster eatonii (A. Gray) Howell
Astragalus vexilliflexus Sheld.
Besseya cinerea (Raf.) Pennell
Bromus marginatus Nees
Carex microptera Mack.
Carex pachystachya Cham.
Carex raynoldsii Dewey
Carex simulata Mack.
Chimaphila umbellata L. Bart. var. *occidentalis* (Rydb.) Blake
Claytonia lanceolata Pursh
Clematis verticillaris DC. var. *columbiana* (Nutt.) A. Gray
Crataegus douglasii Lindl.
Danthonia californica Boland var. *americana* (Scribn.) Hitchc.
Festuca idahoensis Elmer
Heuchera flabellifolia Rydb.
Hieracium albiflorum Hook.
Hieracium cynoglossoides Arv.-Touv.
Juncus ensifolius Wikstr.
Juncus saximontanus A. Nels.
Lithospermum ruderale Lehm.
Mimulus guttatus DC.
Montia linearis (Dougl.) Greene
Osmorhiza purpurea (Coult. & Rose) Suksd.
Perideridia gairdneri (Hook. & Arn.) Mathias
Pinus contorta Loudon var. *latifolia* Engelm.
Polygonum bistortoides Pursh
Potentilla diversifolia Lehm.

Pterospora andromeda Nutt.
Ranunculus cardiophyllus Hook.
Ranunculus inamoenus Greene
Ranunculus pedatifidus J. E. Smith var. affinis (R. Br.) L. Benson
Salix pseudocordata (Andress.) Rydb.
Spirea lucida Dougl.
Stipa columbiana Macoun
Thalictrum occidentale A. Gray
Trisetum wolfii Vasey

P

DISCUSSION

The first clearly formulated ideas on the subject of historical plant geography appeared in a work by Willdenow in 1792 (cited by Wulff 1943) who stated that "by history of plants is meant the influence of climate on vegetation, the changes which plants have probably undergone as a result of the revolutions which have taken place on our globe ...". Willdenow's statement is still valid and applicable to this study. The history of the present flora of southeastern Alberta hinges on revolutionary climatic changes which caused the destruction of plants by glaciations. Subsequent glacial recession and revegetation were the result of equally revolutionary climatic changes.

Equally applicable is De Candolle's definition (quoted by Wulff 1943), who stated in 1855 that the principal aim of "botanical geography" should be "to show what, in the present distribution of plants, may be explained by present climatic conditions and what is a consequence of former conditions".

Plant geography is a study of distribution, or area occupied by plants. Cain (1944) said "that the first task of floristic geography ... is the accumulation of distributional data and their organization on maps." The accumulation of records and their statistical study is the static phase of plant geography. Its dynamic phase consists of elucidating the floristic history of the area and the factors which brought about these historic changes.

What determines the area occupied by plants? According to Beijerinck's informal "law" concerning microorganisms, "everything is everywhere and the milieu (environment) selects" (Pijl 1969). If this were true of vascular plants, any particular pattern of distribution of a taxonomic unit would merely express the ecological preference of the plants it contains and would reveal nothing of its past history. Plants, however, do not spring up anywhere where the environmental conditions are favorable, but spread gradually over continuous terrain where environmental conditions permit. Long distance chance dispersal has not been a factor in populating continental land areas, and migration routes can often be traced through the records left behind in the form of disjunct populations or fossils. Löve (1967) stated that "distribution areas mirror history of the species and its evolutionary divergence, making studies of areas and of the variations of the taxa they represent an important tool for those who study the processes of evolution".

Centres of distribution

As Darwin observed (cited by Wulff 1943), individual species arose in one place at one time and spread from that place to occupy its area. In such glaciated regions, as in northern

North America, the original vegetation was exterminated and subsequently replaced from plant sources surviving in unglaciated areas. If these sources are compact, they are called secondary centres of dispersal (Wulff 1943).

Hultén (1937, 1958) studied the secondary centres of dispersal in the northern hemisphere and succeeded in locating many of them by using the method of overlay maps. Hultén pointed out that plants spread from such centres to available ground in all directions, provided there are no insurmountable obstructions. Plants radiating from the same centre form "equiformal progressive areas". Ideally these areas would be in the shape of concentric circles, the smaller ones representing "rigid" species which spread slowly, and the larger circles the "plastic" species which retained their capacity to spread faster. In reality the areas appear in many shapes, mostly oval. The centre of distribution is detected by noting where the greatest number of species accumulate.

When attempting to trace the origins and migration patterns of the plants which make up the present flora of east-central and southeastern Alberta, the starting point has to be the extinction of the biota by the Pleistocene glaciations. All geological evidence (Ellwood 1962; Bayrock 1967; Westgate 1968) shows that, with the exception of the Cypress Hills Plateau, the study area was completely glaciated during the Wisconsin ice age. Botanical investigations, including this study, have failed to uncover such evidence, as endemism, which would indicate that plants have survived here *in situ* during the Pleistocene.

Limitations of palynological methods

Indications for possible migration routes come from two main sources. First, fossilized pollen and other plant remains provide direct evidence indicating the time certain genera were present at or near a particular site (Colinvaux 1967; Wright 1971). Secondly, modern plant distributions show the present state of these migrations. The limitations of fossil records have been pointed out by many researchers, notably by Wright (1971) and Ritchie (1976). Their findings are summarized as follows: (1) Fossil pollen records start some time after revegetation, (2) the data is seldom specific and only certain groups of plants are represented and (3) there is a lack of fossil pollen studies in southeastern Alberta due to the scarcity of preservation sites. (4) From the pollen profiles it is possible to reconstruct vegetation types of the past but not to assemble lists of species for a given plant community. One has to extrapolate by making assumptions on the basis of ecological preference and the structure of known plant communities. (5) While ecological requirements of species are not likely to change in the span of 12,000 years, biotic communities of the past usually do not have modern analogues (Ashworth and Brophy 1972). For the above reasons any reconstruction of the early stages of revegetation remains speculative.

Limits of phytogeographical methods

Distribution maps are also limited owing to the incompleteness of collection records and to the fact that the geographic range of one or two species is not sufficient foundation for interpreting past migration patterns. As Packer (1971) observed, only when we compare the distributions of a large number of species and consider them in the light of genetic and ecological factors, can we advance useful hypotheses with respect to the history of the flora.

Such a method works successfully if a large number of representative species is considered, there has not been a major shift in the distribution pattern of the plants under examination, and if endemic or isolated populations populations are present in the study area. Centres of distribution were thus located by Hultén (1937) in Beringia and eastern Asia. Trying to discern migratory history by examining the area of widespread species may lead to false conclusions. *Picea glauca* occurs mainly north of the 50th parallel and therefore it can be classified as a northern species. Its present area stretches from the Pacific to the Atlantic oceans and it is well represented in Alaska. From the distribution pattern one could assume that *Picea glauca* spread from several survivia, including Alaska. Picea glauca is, however, one of the few species whose glacial history and post-glacial migration route have been well documented by fossil evidence. Palynological data (Wright 1971) indicate that Picea survived south of the boundaries of the Wisconsin ice sheet, and that it was absent in glaciated Alaska and Yukon during full glacial times (Ager 1975; Ritchie 1977). The area of Picea glauca has shifted northward leaving no indication of the extent of its one-time southern territory.

Distribution patterns of even a large number of species may give a false impression. If we overlay the areas of the southern or prairie species reaching the study area, we find that their overlapping areas "pile up" in central Montana. We know, however, that central Montana was probably covered by a Picea forest during glacial times and that the prairie plants no doubt survived further south of this forested area (Wright 1971). In this case the method of the equiformal progressive areas is not useful because only Great Plains species which happen to reach southeastern Alberta are included. These species happen to occupy a similar ecological niche, and their distribution reflects the influence of present climatic conditions telling little of their past history. It appears that the method of examining species area and concentration for the purpose of locating centres of distribution is most successful when endemic species are also examined. Southeastern Alberta, however, does not contain endemic species or centres of dispersal and the species reaching the study area are not the most reliable for pinpointing centres occurring somewhere else.

Area and migration theories

One of the earliest principles of plant geography has been the primary role of climate in the control of plant distributions (Wulff 1943). No plant is truly cosmopolitan, that is inhabiting the entire globe, for no vascular plant is adapted to both tropical and arctic environments. A change in the climate usually results in the migration of species since climatic shifts are faster than the changes in the tolerance of plants. If climatic conditions in one part of the area become unfavorable, plant reproduction and survival will be hindered and the area occupied will contract there. If the same climatic shift expands the favorable environment in the opposite direction, population movement will result. A migratory route is formed by the continuity of suitable environmental conditions while unsuitable conditions form a barrier. Cain (1944) quoted Mason saying that "climate seems to be the only significant variable that operates from one region to another in a manner which would stimulate the migration of floras".

Areas may be continuous or discontinuous, but, as Cain (1944) observed, even "within their areas, species populations do not have absolutely continuous distributions ..." The discontinuities are caused by environmental factors, such as topographic, climatic and edaphic variations of potential plant habitats". Cain (1944) observed that "minor discontinuities of areas frequently result from recent migrations, but major disjuctions seem almost exclusively to have resulted from historical causes ... through destruction or divergent migrations caused by climatic or some other changes". If the gaps between parts are significant, the outlying portions are called disjunct areas. As Hultén (1937) pointed out "... the stations found outside the compact area ... can give a clue as how the development (of the area) has taken place. They are 'the living fossils' of the species in question." In one of the earliest observations, Darwin (cited by Wulff 1943) noted that the distribution of arctic-alpine disjuncts suggest that the arctic flora migrated southward during glaciations and remained stranded on mountain tops after the glaciers retreated. Fernald (1925) discussed in detail the problem of endemic and disjunct species in eastern America, especially the Gaspe Peninsula and western Newfoundland. Fernald examined the possibility that the isolated species were carried to their present location by water or animals, or that they arrived by gradual migration overland in late glacial times. He came to the conclusion that none of these factors were responsible for the discontinuity of the species in question, but that these species survived the

Wisconsin glaciation *in situ*.

In southeastern Alberta there is no evidence for glacial survival *in situ*, but the Cypress Hills flora contains many species which were separated from their next occurences in the Rocky Mountains and the boreal forest by hundreds of kilometres during early postglacial times. Since the period when these species became isolated is well known, the disjunct species represent an important landmark which helps to elucidate the postglacial migrational history of southeastern and east central Alberta.

Dispersal of propagula

Pijl (1969) defined dispersal as the active or dynamic process of transportation of propagula, differentiating it from the result it may lead to: the passive or static state of distribution. The word dissemination is often used as an alternate term. The methods of dispersal by which a plant may spread are important to the plant geographer because they may provide circumstantial evidence supporting theories about the routes and timing of past plant migrations (Pijl 1969). The long standing controversy over long distance dispersal often revolved around the physical and physiological possibilities of moving a viable propagule over the the distance in question (Fernald 1925, Pijl 1969, Iltis 1973).

In a study cited by Cain (1944) Molinier and Muller classified propagula according to type, adaptations for dispersal and mode of dispersal. According to their classification there are anemochores which are carried by the wind, hydrochores which are species dispersed by water or with the help of humidity triggering the discharge of propagula. Zoochores are carried by animals, anthropochores are dispersed by man; autochores are dispersed through the action or structure of the mother plant and barachores merely drop their propagula that have no special structures aiding dispersal. Within these main categories there are several subdivisions. Such other authors, as Pijl (1969), set up a more elaborate classification, but the one by Molinier and Muller seem to be the one most widely used.

Dispersal of propagula does not, of course, mean that they are always established. Cain (1944) observed that "dissemination is a chance phenomenon in the sense that there is no possibility of cooperation between diaspores and agents to assure the movement of a diaspore to a place which is suitable for its germination and establishment".

The late-glacial landscape

To understand the process of revegetation in southeastern Alberta, it is necessary to examine the late glacial environment. Deglaciation involved both frontal retreat and ablation or melting in place (Westgate 1967, Westgate1968).

Frontal retreat is characterized by linear disintegration ridges and endmoraines running at right angles to the direction of glacier advance and retreat. These features are most prominent south of the Cypress Hills. Most of the study area is, however, characterized by dead ice features which were formed as follows: During the glacial advance the thrusting forces within the ice carried till material onto the surface of the glaciers where it accumulated forming layers of varying thicknesses. Where the debris was thick, its insulating effect delayed melting of the ice by hundreds or even thousands of years (Clayton 1967). The differential rate of melting produced depressions where water accumulated and formed superglacial lakes. During the course of melting some of the debris slumped into the depressions and new depressions were created when the ice blocks finally melted and the superglacial debris collapsed. The landforms which have resulted are the undulating ground moraine and the hilly hummocky moraine which contain numerous "kettle holes" or small ponds. Flutings, drumlins and eskers also added to the topographic relief of the area.

The late glacial landscape consisted therefore of ice-free areas, superglacial debris and buried or partially buried ice blocks. The glacial debris which formed the surficial medium for recolonization lacked soil horizon development and organic matter accumulation characteristic of developed soils. Oxidation and leaching did not have an impact for some time after deglaciation and organic matter accumulation began only when vegetation became established. Recolonizing plants therefore had to contend with a medium equivalent to modern regoliths lacking organic matter, nutrient nitrogen and microfloral development, and which often had poor structure resulting in crusting. Since the land surface was unprotected against erosion by water or wind, the early postglacial times were periods of slope modification and of intense gully and sand dune formation. Vegetation probably invaded the superglacial till atop stagnant ice as well. Modern analogues of vegetation growing on top of buried ice are found in the Klutlan glacier area in south western Yukon (Clayton 1967).

In addition to the upland features, the evidence for large amounts of water streaming from the glaciers is everywhere (Grovenor and Green 1962; Wesgate 1968). Glacial outwash and meltwater channels indicate fast moving cold meltwaters which probably prevented the establishment or any buildup of aquatic plants. Some of the meltwater accumulated in temporary superglacial and proglacial lakes confined by the glacier ice. Buried plant remains show aquatic vegetation in ice-contact lakes (Clayton 1967).

Sequence of revegetation

The kinds of plants which colonized the newly available glaciated areas were dependent on two factors. Firstly, the species whose viable propagula were available and secondly, suitable habitats for the establishment of these propagula. Many of the modern colonizers of disturbed areas have been recently introduced from Eurasia (Frankton 1961). They are weeds and plants which have escaped cultivation. In the aspen parkland area the first weeds to occupy exposed soil are the *Sonchus arvensis*, *Capsella bursa-pastoris*, *Thlaspi arvense* and *Cirsium canadensis*. Introduced crop plants can only flourish in the absence of competition and they are frequent colonizers of bare soil where moisture conditions are sufficient for their growth. *Melilotus officinalis*, *Melilotus albus*, *Bromus inermis* and *Trifolium repens* often escape cultivation and invade disturbed sites. These modern colonizers were not avaiable in late glacial times.

The stagnant ice landscape offered dry surfaces and ponds both on ice-free areas and on superglacial deposits (Clayton 1967). Among the first colonizers of aquatic sites were *Chara* and *Lemna* (Clayton 1967). These plants may have been carried in by waterfowl. Ponds newly created by road construction in southeastern Alberta frequently contain such pioneering species as *Alisma plantago-aquatica*, *Polygonum amphibium*, *Potamogeton richardsonii*, and *Myriophillum exalbescense* in shallow waters. An important colonizer of moist shorelines is *Potentilla anserina* and *Hordeum vulgare*. Certain species invade non-vegetated areas faster than others. *Calamagrostis canadensis* was shown to be an important colonizer of disturbed sites in the Northwest Territories (Younkin 1974) and probably played a part in recolonizing the shorelines of glacial and superglacial lakes. In dry sites *Artemesia frigida* frequently increase in the absence of competition and is therefore a likely candidate for primary invasion. The neoglacial moraines of the Klutlan Glacier in the St. Elias mountains of the Yukon provide modern analogues for the sequence of revegetation. *Epilobium angustifolium* and *Dryas* are followed by *Salix* and later *Picea*, all on the rock debris covering the dead ice (Clayton 1967; Wright 1976). Hultén (1937) examined an area in uninhabited southern Kamchatka in eastern Siberia where volcanic action has cleared 250 square kilometres of all vegetation. He visited the same area 14 years after the eruption and noted that only *Equisetum arvense* and *Epilobium angustifolium* were able to invade the volcanic desert. These widespread species were very likely among the first colonizers of glacial débris.

The very early stages of plant succession are unfortunately seldom recorded because the lakes or ponds in which pollen and other fossils accumulate do not always form immediately after the retreat of active ice (Wright 1971, 1976). Superglacial lakes are ephemeral and stratigraphic structure is disturbed by slumping in the course of ice letdown (Clayton 1967). Glacial lakes may also be drained catastrophically once the ice block has melted. S. Moran and

M. Fenton of the Alberta Research Council (pers. comm.) estimate that basal carbon dates may be 2000 years younger than deglaciation. In southern Alberta a patchwork of thousands of square kilometres of stagnant ice and glacial debris was available for recolonization, but the precise extent of the stagnant ice at a given time is not known (Moran and Fenton pers. comm.). It is probable that colonizing vegetation advanced in an uneven fashion, taking advantage of the various habitats on the glacial debris. The overall picture of plant migrations was simpler here than in the Great Lakes region where lobation and significant readvances of the glaciers were important factors (Wright 1976). Large glacial lakes were also absent in southern Alberta (Bayrock 1967; Westgate 1968).

The sequence of revegetation also depended on the presence of certain species and their propagula adjacent to the glaciated areas. It is a fundamental and self evident concept of plant geography that if historical factors dictate that viable propagules are absent, colonization cannot take place no matter what the ecological conditions may be. Pollen and other fossil remains provide us with only limited information about the genera and species which may have provided viable propagula for recolonization. It has been shown that a belt of _Picea_ forest containing species of _Betula_, _Alnus_, _Artemisia_ and Gramineae lay south of the Wisconsin ice (Wright 1971; Ritchie 1976). _Populus_ and _Salix_ were also present forming a zone between the *Picea* forest and the ice sheet (Mott 1976; Ritchie 1978). The presence of the numerous other species normally part of a *Picea* and *Populus* forest and associated vegetation we can only infer. These include *Linnaea borealis*, *Pyrola asarifolia*, *Bromus ciliatus*, *Corylus cornuta*, *Thalictrum venulosum*, *Viola adunca*, *Sanicula marilandica*, *Cornus stolonifera*, *Lonicera dioica*, *Symphoricarpos albus*, *Maianthemum canadense*, *Cornus canadensis*, *Rubus pubescens*, *Aster ciliolatus*, *Anemone canadensis*, *Lathyrus ochroleucus*, *Ribes oxyacanthoides*, *Fragaria virginiana*, and *Disporum trachycarpum*.

Lofty Lake, about 100 km north of the study area, is the nearest site where a pollen profile is available (Lichti-Fedorovich 1970). This profile shows a basal zone dominated by pollen of *Populus*, *Salix* and *Artemisia* species as well as of members of the Gramineae and Cyperaceae. This is followed by a zone of abundant *Picea* pollen dated at 11,400 B.P. (Mott 1976). This sequence could mean that a herbaceous pioneer vegetation occurred concurrently with *Populus*. Herbaceous vegetation may have also preceded *Populus*, but a record is not available possibly because of the lag in the formation of lakes suitable for the preservation of fossil pollen. The herbaceous plants which may have been involved include some of the species which commonly colonize available moist or wet habitats. The following are some examples. *Equisetum laevigatum*, *Typha latifolia*, *Alisma*

plantago-aquatica, *Calamagrostis canadensis*, *Glyceria borealis*, *G. grandis*, *Hordeum jubatum*, *Poa palustris*, *Beckmania sysigachne*, *Spartina gracilis*, *Carex aquatilis*, *C. lasiocarpa*, *Lemna trisulca*, *Juncus balticus*, *Polygonum amphibium*, *P. coccineum*, *Rumex mexicanus*, *Ranunculus aquatilis*, *R. cymbalaria*, *Stellaria longipes*, *Epilobium glandulosum*, *Myriophyllum exalbescens*, *Cicuta douglasii*, *Glaux maritima*, *Mentha arvensis*, *Artemisia biennis*, *A. campestris*, *A. frigida*.

Although moist and wet sites were abundant at the time of deglaciation, the sorted sands and gravels of glacial outwash and eskers presented well drained habitats which may have been colonized by *Carex foena*, *Arabis holboellii*, *Erysimum asperum* and *Epilobium angustifolium*.

At their maximum, the Wisconsin glaciers extended in western Canada to the vicinity of the 50th parallel, and began to withdraw about 17,000 B.P. (Prest 1968). This process was complicated by uneven melting, minor readvances and lobation. A narrow ice-free area opened along the foothills of the Rocky Mountains and by 12,000 B.P. the entire study area was free of active ice. An early postglacial *Populus* forest reached central Alberta around 11,400 B.P. (Mott 1976), and a *Picea* dominated forest followed soon after. The latter was spreading fast, as shown by the short time-lag between the sites in southern Saskatchewan and the one in central Alberta (Ritchie and Yarranton 1978). This precursor of the modern boreal forest lacked *Pinus* and the tree forms of *Betula*. There are no pollen studies available for the study area but, in nearby southern Saskatchewan, profiles from the Herbert, Hafichuk and Scrimbit sites (Ritchie 1976) show that *Picea* pollen reached its peak about 11,500 B.P. and declined a thousand years later, indicating the presence of a *Picea* dominated forest for the period. At that time the levels of *Artemisia* and Gramineae pollen rose, concurrently with a change to a warmer and drier climate. *Pinus* appeared in central Alberta about 7500 B.P. It was unable to reach the Cypress Hills which, by this time, were separated from the forested regions by a wide belt of xerophytic prairie vegetation composed mostly of such herbaceous plants as *Agropyron spicatum*, *Koeleria cristata*, *Stipa comata*, *S. spartea var. curtiseta*, *S. viridula*, *Allium textile*, *Eriogonum flavum*, *Atriplex nuttalii*, *Eurotia lanata*, *Lesquerella arenosa*, *Erysimum inconspicuum*, *Potentilla pensylvanica*, *Astragalus striatus*, *Astragalus tenellus*, *Oxytropis campestris*, *Linum rigidum*, *Opuntia polyacantha*, *Gaura coccinea*, *Lomatium foeniculaceum*, *Phlox hoodii*, *Orthocarpus luteus*, *Antennaria nitida*, *Artemisia frigida*.

Between 8500 and 5500 B.P. the *Picea* forest and its successor, the modern boreal forest, shifted northward, replacing the treeless tundra (Ritchie and Hare 1971) and at the same time yielding to grassland vegetation in its southern parts (Ritchie and Yarranton 1978).

VEGETATIONAL AND PHYTOGEOGRAPHIC ZONES

The study area contains well known vegetational zones defined by climatic parameters. The vegetational zones also proved to be phytogeographic units determined by the limits of distribution of many species (see Maps 1-20.). This is only to be expected, since the geographic distribution of plants is dependent on climate.

Phytogeographic zones were also delimited on a continental scale showing the affinities of species occurring in the study area with other geographical regions. The global and continental distributions are the result of the effects of climate and of migrational history of the plants.

Within the study area the vegetational and phytogeographic units are the aspen parkland, Cypress Hills, and the prairie. Within these broad categories the area can be divided into smaller and less well defined subunits. Some of the unique features of the western parkland and southeastern prairie will be discussed.

The global and continental categories show the geographical affinities of the species studied and provide some information regarding the postglacial history of these species. These categories are the widespread boreal and temperate species, northern species, south temperate species, eastern American species, western American species, and southern or Great Plains species.

Aspen parkland

The vegetational zones of the study area have been defined both on a phytogeographical and ecological basis. Although the southern boundary of the aspen parkland follows the distribution of one species, Populus tremuloides (Bird 1930; Moss 1932), it is a transition zone, containing species which have affinities with the boreal forest as well as the prairie. The southern limit of Populus tremuloides approximates the 35 cm precipitation line. Outliers are found in the Cypress Hills where the precipitation/evaporation ratio is favorable owing to higher elevation, and also in the sand dune areas of southern Alberta where the ground water lies within reach of Populus roots (Coupland 1950). This indicates that the aspen parkland is presently maintained by certain unique climatic conditions but, at the same time, owe their existence to the historical migration of a postglacial forest. Populus and Picea forests have migrated through Alberta in early postglacial times (Ritchie 1976; Thompson and Kuijt 1976), providing the source for the boreal element of the flora. Prairie vegetation invaded the area during the mid-Holocene at which time the boreal forest and the Populus association of the aspen parkland receded towards the north (Ritchie and Yarranton 1978). The southern part of the boreal forest and the aspen parkland developed in the last 3000 years from a treeless or very sparsely treed vegetation due to the shift of the Arctic Front towards the south (Ritchie and Hare 1971). It is clear that the extent of the aspen parkland vegetation is determined by climatic factors. The boreal-montane vegetation thriving in the Cypress Hills is additional evidence of the importance of climatic control.

A close floristic relationship between the aspen parkland, the boreal forest and Cypress Hills is evident from the number of species which are common to these areas. More than two-thirds of all species occurring in the aspen parkland are also found in the boreal forest, and little more than half in the Cypress Hills. I suggest that the boreal elements of these three areas originate from a common source, namely the early postglacial forest vegetation which migrated through Alberta from the south. The isolated position of the Cypress Hills provides evidence that those species which are present in the Cypress Hills but lacking in the surrounding prairie arrived about 11,500 B.P. from the south.

As indicated by palynological evidence (Wright 1971, Ritchie 1976) and by the floristics of the Cypress Hills (Breitung 1954, Thompson and Kuijt 1976), the general direction of the migration of the early postglacial forest has been from south to north and then northwest into Alaska. It is highly unlikely that plants reached central Alberta directly from the Alaska-Yukon survivium during the period of initial revegetation. Although there is geological evidence for an ice-free corridor from the Yukon to central Alberta, there is no botanical evidence known to me to indicate any plant migration from the north or northwest.

The distribution of some 30 species (see Results). which are found only in the western part of the aspen parkland, poses an interesting problem. The presence of these species may simply be dependent on more favorable moisture conditions, as evidenced by their boundary roughly following the 40 cm mean precipitation curve. On the other hand they may represent an element which is spreading from western sources in response to increasingly favorable climatic conditions. There are 22 species which are restricted to the western part of the aspen parkland and the Cypress Hills. The area of these species were probably reduced in early Holocene at the time when the Cypress Hills became isolated from nearby boreal-montane vegetation by prairie grassland.

There are only eleven species which occur exclusively in the aspen parkland part of the study area. The rest of the species are common to the Cypress Hills and the prairie, reflecting the history of past migrations and the status of the aspen parkland as an ecotone between the boreal forest and the prairie.

Cypress Hills

Although the Cypress Hills occupy only 0.2% of the study area, 44% of the species are represented here. A large portion of this unusually rich flora is a remnant of the early postglacial *Populus* and *Picea* forest which migrated through the area towards the north between 13,000 and 11,000 B.P. (Ritchie 1976; Mott 1978). The present plant communities have survived because of the moister and cooler climate of the plateau (Thompson and Kuijt 1976). A little more than half the species (192 out of 369) are also found in the aspen parkland, suggesting a close floristic relationship between the two areas. There are, of course, notable differences. *Pinus contorta* var. *latifolia* present in the Cypress Hills is absent from northeastern Alberta, while *Pinus banksiana* is absent from the Cypress Hills, but present just north of the aspen parkland. This difference has resulted from the different times of arrival of these two species. *Pinus contorta* var. *latifolia* reached the Cypress Hills from the south or southwest before the Hills became isolated from forested areas, while *Pinus banksiana* arrived in Alberta from the east several thousands of years later, in about 7500 B.P., when the Cypress Hills were surrounded by prairie vegetation (Ritchie 1976).

The prairie

A hundred and seventy one out of the 399 species occurring in the prairie are restricted to the prairie area. This relatively large number suggests that the prairie is floristically well defined. Seventy three species are found only in the southern half of the prairie region and 32 of these are restricted to the extreme southeast corner of the Province. The extent of their distribution has resulted from the combination of climatic, edaphic and historical causes. With the exception of the Cypress Hills, the southeastern corner of Alberta is the driest region in the Province (see Figures 3 and 4 and Table 3). There are several sand dune areas here that provide habitat for plants like *Abronia micrantha*, *Psoralea lanceolata* and *Eriogonum cernuum*. The rare *Yucca glauca* is found in the heavy soil of south facing steep coulee slopes of the Lost River and Milk River (Milner 1977). *Boisduvalia glabella* is found in dried up sloughs which characterize many parts of this area.

Autecological requirements may not be the only reasons why these plants do not occur in the rest of Alberta and some cases the rest of Canada. It seems a reasonable assumption that these species reached the area during the mid-Holocene warm-dry period when the boreal forest and the aspen parkland shifted towards the north and the prairie vegetation expanded. Following the southward shift of the Arctic Front, the climate cooled between 5500 and 3000 B.P.

(Ritchie and Hare 1971) the prairie retreated as well, reducing the areas and the numbers of species requiring the most warmth.

Widespread boreal and temperate species

These elements include the circumpolar plants which are found in Canada from coast to coast (See Maps 21 - 23.). Since the Wisconsin glaciers destroyed plant life over 97% of Canada's land surface (Prest 1969), virtually all colonizing species started from the same base. Members of the widespread group had to migrate farther and presumably faster than species with less extensive areas. Several of the widespread species are aquatics, including *Lemna minor*, *L. trisulca*, *Ranunculus aquatilis*, and five species of *Potamogeton*. Numerous emergent semiaquatic shoreline species belong in this group, namely *Typha latifolia*, *Sparganium eurycarpum*, *Triglochin maritima*, *T. palustris*, *Glyceria grandis* and *Polygonum amphibium* among others. Most of the remaining species are members of the aspen parkland and boreal forest communities as characterized by *Botrichium multifidum*, *B. virginianum*, *Habenaria viridis* and *Pyrola asarifolia*.

In analyzing the flora of Manitoba, Löve (1959) found that 38% of the species were so generally distributed over the continent that it was impossible to tell from where they originated. In Alberta, however, the Cypress Hills provide a unique indicator landmark. The boreal species of the widespread group which are present in the Cypress Hills but not in the surrounding prairie could have reached the area only from the south with the early postglacial forest between 13,000 and 11,000 B.P. This suggests a rather simple picture of postglacial migrations where the majority of the plants are known to have arrived from vegetation belts south of the Wisconsin ice sheet.

Some deductions can also be made on the basis of the ecological affinities of these species. Some of the aquatic and shoreline species in this group are the most likely candidates for the recolonization of the ephemeral superglacial and proglacial lakes and of the more permanent bodies of water that were established after the ice had melted. Since most of the widespread species are part of the modern boreal forest, we can expect that they were present in the Picea forest south of the Wisconsin ice sheet.

As Hultén (1937) observed, the species which survived south of the glaciers were not isolated in between ice sheets and their gene pool was not depauperated to the extent that they lost their ability to spread. It is natural then that the widespread plants should belong in this group.

Northern species

Nearly all plants belonging in this group are now members of the boreal and aspen forest communities (see Map 24.). Some of the characteristic forest species are Picea glauca, Maianthemum canadense, Habenaria obtusata, Populus balsamifera, Viburnum edule, Petasites vitifolius and Aster ciliolatus. Open moist sites are characterized by Ranunculus flammula, R. macounii and Antennaria pulcherrima. Aquatic species are represented by Ranunculus circinatus var. subrigidus. These species probably survived south of the icesheet as indicated by the history of Picea glauca, which has been shown to occupy a belt south of the Wisconsin glaciers (Wright 1971) and then migrated north following the retreat of the ice. The northern species have a similar history and ecological preference as the widespread boreal species and were probably part of the pioneering Populus and Picea forests. Evidence also comes from their presence in the boreal - montane forest flora of the Cypress Hills, whose source is known to be the early postglacial Populus and Picea forests which survived south of the glacial ice sheets.

Several of the widespread boreal plants, including the Northern species, have broken distribution patterns in North America. Astragalus eucosmus is such a species, present in northeastern and northwestern Canada and in the Rocky Mountains (see Map 24), but has significant gaps in central

Canada. This suggests a more continuous distribution in early Holocene but its range became broken up during the warm-dry Hypsithermal between 8500 and 5500 B.P. and it never regained its former territories.

South temperate species

These species are widespread in south-temperate North America, ranging from central Alberta to Texas and often spanning the continent (see Maps 25 and 26.). Their source could have only been south of the ice margin. Their time of arrival followed the retreat of the *Picea* forest towards the north about 10,000 years ago. The extent of their area may have expanded during the Hypsithermal (Ritchie and Hare 1971) and retreated between 5500 and the present.

Several species belonging in this group which are found in saline mudflats. These species are *Chenopodium glaucum* var. *salinum*, *Myosorus minimus*, *Iva axillaris*. Some of the species occur in the moist soil along stream banks, as exemplified by *Populus sargentii*, *Salix amygdaloides*, *Sphenopolis obtusata*, *Ellisia nyctela*. The ones which occupy waste places are *Festuca octoflora*, *Chenopodium hybridum*, *Amaranthus albus*, *Euphorbia glyptosperma*, *Lactuca pulchella*, *Xanthium strumarium*. Typical of sandy places is the *Sporobolus cryptandrus*. Woodland species belonging in this group are *Corallorhiza striata*, *Lysimachia ciliata* and *Lysimachia hybrida*.

Eastern American species

These species reached the study area from the south east (see Maps 27 and 28.). Their low number may be explained by the fact that southern Alberta is closer to western sources of plants. This is in contrast to the floral composition in Manitoba, where nearly half of the species which have definite geographical affinities reached that province from the east (Löve 1959).

Some of the plants belonging in this group are found in sandy soil with adaquate moisture for the growth of *Populus tremuloides*. Examples of this category are *Elymus virginicus*, *Spirea alba*, *Petalostemon candidum* and *Oenothera biennis*. The one eastern species whose postglacial history has been traced in detail through the use of pollen profiles is *Pinus banksiana*. During the height of the Wisconsin glaciation *Pinus banksiana* survived in southeastern United States (Yeatman 1967; Wright 1971). It reached Minnesota by 10,000 B.P. (Bernabo and Webb 1977) and western Manitoba and adjacent Saskatchewan by 7500 B.P. By the time it reached Alberta, the southern part of the Province was occupied by prairie grassland isolating the boreal-montane forest of the Cypress Hills. Some eastern American species now present in the boreal forest, Cypress Hills and the *Populus tremuloides* associations in the aspen parkland are *Carex lacustris*, *Salix serissima*, *Anemone canadensis*, *Agrimonia striata* and *Lathyrus ochroleucus*. These species are widespread in temperate eastern North America and their presence in the Cypress Hills indicates that they must have arrived with the early postglacial forests before 10,000 B.P., that is before the Cypress Hills became isolated from forested areas elsewhere.

Western American species

The distribution area of these species stretches from Alaska to California and tapers towards the east. Some of the species widespread in western America are found under tree cover in the boreal forest, aspen parkland and the Cypress Hills. Examples of these species are *Ribes hudsonianum*, *R. oxyacanthoides*, *Fragaria virginiana*, *Viola rugulosa*, *Mertensia paniculata* and *Actaea rubra*. There are also many emergent aquatic species such as the *Alisma plantago aquatic*, *Rumex mexicanus*, and *Cicuta douglasii*.

Virtually every one of the species found in forested or aquatic habitats also occurs in the Cypress Hills, but not in the surrounding areas. This fact again helps to pinpoint the direction and the time of arrival of these species as having come from the south or southwest before the Cypress Hills became isolated from the boreal and montane forests.

Other western species are prairie plants as exemplified by *Cxytropis campestris*, *Potentilla gracilis*, *Erigeron caespitosus* and *Helianthus annuus*. I suggest that the xerophytic prairie plants originated from the dry grassland areas which lay south of the *Picea* forest during full glacial and early post-glacial times. During this period the Alaska-Yukon survivium had tundra vegetation dominated by dwarf *Betula* and *Shepherdia canadensis* (Ritchie and Hare 1971), and did not provide suitable environment for xerophytic vegetation.

The northern boundary of the western species tapers towards the southwest, paralleling the position of the Arctic Front (Bryson et al. 1968). The climate of the Hudson Bay area has been much colder than that of the Alaska region and blocked the spread of the mainly temperate species of the western group.

Southern or Great Plains species

Most of the prairie species have a compact distribution range lying within the Great Plains or centred around the southern ranges of the Rocky Mountains. These are grassland and southwestern semi-desert species from the Great Plains, intermountain areas and from the Rocky Mountain foothills (Wells 1968) as exemplified by *Agropyron dasystachyum*, *Aristida longiseta*, *Bouteloua gracilis*, *Calamovilfa longifolia*, *Helichtotrichon hookeri*, *Muhlenbergia cuspidata*, *Poa arida*, *Stipa spartea var. curtiseta*, *Carex heliophila*, *Alluim textile*, *Eriogonum flavum*, *Suckleya suckleyana*, *Lesquerella arenosa*, *Potentilla concinna*, *Astragalus* caespitosus, A. triphyllus, Thermopsis rhombifolia, Viola nuttallii, Opuntia polyacantha, Cymopterus acaulis, Cryptandra bradburiana and Lithospermum incisum.

During the cool period of Wisconsin times when the entire central interior of the Continent was occupied by a Picea forest as far south as Illinois and Kansas (Wright 1971), the prairie grassland vegetation became narrowed and was shifted southward as well. During the warming trend, culminating in the Hypsithermal, the prairie grassland shifted northward occupying an area north of its present limit (Ritchie and Yarranton 1978). With the subsequent cooling of the climate in the late Holocene the area of the southern species retreated towards the south.

CONCLUSIONS

1. Not considering the widespread species, the North American distribution of most plants of southeastern Alberta show affinities with western North America.

2. Most of the postglacial revegetation of the study area occurred in early postglacial times, before 10,000 B.P., with only minor modifications after that date.

3. The sources of plant species which are found in forested and aquatic habitats were the early postglacial *Populus* and *Picea* forests.

4. The approximate direction of the migration was from south to north.

5. No evidence was found to show plant migration into the study area from the northwest, that is, from the Alaska-Yukon survivium.

6. The most important evidence for the timing and direction of migrations is provided by the floral affinities and the time of isolation of the boreal-montane forest in the Cypress Hills. The dates for the revegetation and isolation of the Cypress Hills are provided by palynological studies from nearby sites.

7. The present day North American distribution patterns of the widespread boreal-montane and aspen parkland species were not found to be as useful for the elucidation of postglacial migration patterns as anticipated.

8. As evidenced by the study of plant distribution patterns and pollen profiles, the prairie species arrived concurrently with the northward migration of the early postglacial *Picea* forest. An open, coniferous savanna vegetation south of the *Picea* forest was the probable source of prairie vegetation which colonized the study area.

9. The sequence of revegetation in the study area was not complicated by major glacial readvances, lobes or large bodies of glacial lakes. The early colonizers were probably the species which today invade newly formed aquatic habitats and bare ground and which were present in the late glacial periglacial vegetation.

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Appendix

LIST OF SPECIES REPORTED FOR THE STUDY AREA.

Nomenclature follows Moss (1959), except for new additions. Collection numbers without name are mine. Voucher specimens are deposited in the herbaria of the University of Alberta (ALTA) and Lakeland College, Vermilion, Alberta. The voucher specimens and distribution maps (cited as: U. of A. distr. map) have been verified by Dr. J. G. Packer.

OPHIOGLOSSACEAE

Botrychium multifidum (Gmel.) Rupr. Kinsella 53°03'N 111°32'W, Ostafichuk Oct. 16, 1972

Botrychium virginianum (L.) Sw., Cypress Hills (de Vries and Bird 1968);

MARSILEACEAE

Marsilea mucronata A. Br., (Moss 1959).

POLYPODIACEAE

Cystopteris fragilis (L.) Bernh., (U. of A. distr. map).

Gymnocarpium dryopteris (L.) Newm., Cypress Hills (Breitung 1954).

Woodsia oregana D. C. Eat., (Moss 1959)

EQUISETACEAE

Equisetum arvense L., Dillberry Lake 52°35'N 110°01'W, 2079 Two Hills 53°40'N 111°05'W, 890; (Breitung 1954)

Equisetum fluviatile L., (U. of A. distr. map).

Equisetum hyemale L., HW 41 x Battle River 53°00'N 110°52'W, 408;

Equisetum laevigatum A. Br., Horseshoe Lake 52°21'N 110°44'W, 820; Chappice Lake 50°09'N 110°21'W, 644; Orion 49°25'N 110°50'W, 2312; Writing-on-Stone (de Vries 1968).

Equisetum palustre L., (U. of A. distr. map).

Equisetum pratense Ehrh., Cypress Hills (Breitung 1954).

Equisetum scirpoides Michx., Cypress Hills (de Vries and Bird 1968).

Equisetum sylvaticum L., Cypress Hills (U. of A. distr. map).

Equisetum variegatum Schleich., Horseshoe Lake 52°21'N 110°44'W, 819.

LYCOPODIACEAE

Lycopodium annotinum L., Cypress Hills (Breitung 1954).
Lycopodium complanatum L., Cypress Hills (de Vries and Bird 1968).

SELAGINELLACEAE

Selaginella densa Rydb., Edgerton 52°45'N 110°28'W, 409.

PINACEAE

Juniperus communis L., Hand Hills 51°23'N 112°12'W, 579; Cypress Hills (Breitung 1954).
Juniperus horizontalis Moench, Dillberry Lake 52°35'N 110°01'W; Writing-on-Stone 49°07'N 111°39'W; Wainwright 52°45'N 110°49'W; Stettler 52°20'N 112°55'W; Cypress Hills (Breitung 1954).
Juniperus scopulorum Sarg., Onefour 49°06'N 110°36'W, (Harms and Hjertaas 1976).
Picea glauca (Moench) Voss, Battle R. - HW 14, 2418; Cypress Hills (Breitung 1954).
Pinus contorta Loudon var. *latifolia* Engelm., Cypress Hills (Breitung 1954).

TYPHACEAE

Typha latifolia L., Provost 52°11'N 110°26'W, 2111. Very common throughout the area.

SPARGANIACEAE

Sparganium angustifolium Michx.
Sparganium eurycarpum Engelm., Vermilion 53°22'N 110°53'W;
Sparganium multipedunculatum (Morong) Rydb., (U. of A. distr. map).

NAJADACEAE

Najas flexilis Rostk. & Schmidt Cypress Hills (de Vries and Bird 1968).
Potamogeton filiformis Pers. Pinhorn grazing res. 49°05'N 110°55'W, 2393.
Potamogeton friesii Rupr., (U. of A. distr. map).
Potamogeton gramineus L., (Moss 1959).
Potamogeton pectinatus L., Vermilion 53°22'N 110°53'W, 398; Two Hills 53°40'N 111°05'W, 1349; Altario 51°49'N 110°11'W, 2178;
Potamogeton pusillus L., Wainwright 52°45'N 110°49'W, 225.
Potamogeton richardsonii (Benn.) Rydb., Vermilion 53°22'N 110°53'W, 233; Acadia Valley 51°15'N 110°13'W, 2146; Cypress Hills (Breitung 1954).
Potamogeton vaginatus Turcz., Cypress Hills (Breitung 1954).
Ruppia occidentalis S. Wats., Brooks, Keith Aug. 1954.

Zannichellia palustris L., (U. of A. distr. map).

JUNCAGINACEAE

Triglochin maritima L., Provost 52°11'N 110°26'W, 430; Wainwright 52°45'N 110°49'W, 2010; Writing-on-Stone 49°07'N 111°39'W, 1107; Horseshoe Lake 52°21'N 110°44'W, 749; Common throughout the area.
Triglochin palustris L., (Moss 1959).

LILAEACEAE

Lilaea scillioides (Poir.) Haum., (Moss 1959).

ALISMACEAE

Alisma gramineum K. C. Gmel., (U. of A. distr. map).
Alisma plantago-aquatica L., Seven Persons 49°52'N 110°53'W, 617; Provost 52°11'N 110°26'W, 328; Walsh 503107'N 110°04'W, 1569; Wildhorse 49°01'N 110°15'W 2260;
Sagittaria cuneata Sheld., Empress 50°57'N 110°01'W, 710; Hand Hills 51°23'N 112°12'W, 1767; Acadia Valley 51°15'N 110°13'W, 2145; Cypress Hills (Breitung 1954).

GRAMINEAE

Agropyron albicans Scribn. & Smith, (Breitung 1954; Moss 1959).
Agropyron dasystachyum (Hook.) Scribn., Isley 53°18'N 110°33'W, 518; Neutral Hills 52°10'N 110°51'W, 306;
Agropyron inerme (Scribn. & Smith) Rydb., Isley 53°18'N 110°33'W, 521; Empress 50°57'N 110°01'W, 685; Seven Persons 49°52'N 110°53'W, 583.
Agropyron riparium Scribn. & Smith, Writing-on-Stone 49°07'N 111°39'W, 1679; Aden 49°04'N 111°17'W, 1650; Nose Hills 52°10'N 111°10'W, 559; Hand Hills 51°23'N 112°12'W, 1257; Isley 53°18'N 110°33'W, 518.
Agropyron smithii Rydb., Kinsella 53°03'N 111°32'W, 1268; Empress 50°57'N 110°01'W, 686; Big Knife 52°29'N 112°11'W, 1888.
Agropyron spicatum (Pursh) Scribn. & Smith, Horseshoe Lake 52°21'N 110°44'W, 453; Big Knife 52°29'N 112°11'W, 1930; Seven Persons 49°52'N 110°53'W, 596.
Agropyron subsecundum (Link) Hitchc., Big Knife 52°29'N 112°11'W, 1883; Isley 53°18'N 110°33'W, 1812; Wainwright 52°45'N 110°49'W, 949.
Agropyron trachycaulum (Link) Malte, Empress 50°57'N 110°01'W, 719; HW 41 x Battle River 53°00'N 110°52'W, 1336; Empress 50°57'N 110°01'W, 704.
Agrostis exarata Trin., (Breitung 1954; Moss 1959).
Agrostis scabra Willd., Big Knife 52°29'N 112°11'W, 1880; Wainwright 52°45'N 110°49'W, 950; Dillberry Lake 52°35'N 110°01'W, 1454.

Alopecurus aequalis Sobol., Seven Persons 49°52'N 110°53'W, 2209; Altario 51°49'N 110°11'W, 2139; Birch Lake 53°19'N 111°29'W, 834.

Alopecurus geniculatus L., Walsh 503107'N 110°04'W, 1566.

Aristida longiseta Steud., Writing-on-Stone 49°07'N 111°39'W, 1671; (Moss 1959).

Beckmannia syzigachne (Steud.) Fern., Walsh 503107'N 110°04'W, 1567; Dillberry Lake 52°35'N 110°01'W, 2076; Altario 51°49'N 110°11'W, 2137.

Bouteloua gracilis (HBK.) Lag., Kinsella 53°03'N 111°32'W, 1839; Big Knife 52°29'N 112°11'W, 1937; Dinosaur 50°45'N 111°34'W, 1738.

Bromus anomalus Rupr., Big Knife 52°29'N 112°11'W, 1684; Dillberry Lake 52°35'N 110°01'W, 1429; Grant Creek 49°28'N 110°05'W, 1593.

Bromus ciliatus L., Isley 53°18'N 110°33'W, 1814; Kinsella 53°03'N 111°32'W, 1843.

Bromus marginatus Nees, Cypress Hills (Breitung 1954).

Bromus pumpellianus Scribn., Kinsella 53°03'N 111°32'W, 1314; (Breitung 1954).

Bromus purgans L., (Moss 1959).

Bromus tectorum L., Seven Persons 49°52'N 110°53'W, 630; 1185; (de Vries 1968).

Calamagrostis canadensis (Michx.) Beauv., Isley 53°18'N 110°33'W, 1817; Dillberry Lake 52°35'N 110°01'W, 2062; Big Knife 52°29'N 112°11'W, 1914.

Calamagrostis inexpansa A. Gray, Dinosaur 50°45'N 111°34'W, 1719; Provost 52°11'N 110°26'W, 2110; Writing-on-Stone 49°07'N 111°39'W, 1659.

Calamagrostis montanensis Scribn., Wainwright 52°45'N 110°49'W, 1356; Kinsella 53°03'N 111°32'W, 1326;

Calamagrostis neglecta (Ehrh.) Gaertn., Dillberry Lake 52°35'N 110°01'W, 2057.

Calamagrostis purpurascens R. Br., Cypress Hills (Breitung 1954; Moss 1959).

Calamagrostis rubescens Buckl., Cypress Hills (Breitung 1954).

Calamovilfa longifolia (Hook.) Scribn, Horseshoe Lake 52°21'N 110°44'W, 801; Wainwright 52°45'N 110°49'W, 948; Big Knife 52°29'N 112°11'W, 1938.

Catabrosa aquatica (L.) Beauv., (Breitung 1954; Moss 1959).

Cinna latifolia (Trev.) Griseb., (Breitung 1954).

Danthonia californica Boland var. *americana* (Scribn.) Hitchc., (Breitung 1954; Moss 1959).

Danthonia intermedia Vasey, Empress 50°57'N 110°01'W, 718; Seven Persons 49°52'N 110°53'W, 591; Kinsella 53°03'N 111°32'W, 1863.

Danthonia spicata (L.) Beauv.,

Deschampsia caespitosa (L.) Beauv., Horseshoe Lake 52°21'N 110°44'W, 773; HW 41 x Battle River 53°00'N 110°52'W, 1335; Altario 51°49'N 110°11'W, 1498.

Distichlis stricta (Torr.) Rydb., Writing-on-Stone 49°07'N 111°39'W, 1681; Dinosaur 50°45'N 111°34'W, 1730;

Chappice Lake 50°09'N 110°21'W, 640.

Echinochloa pungens (Poir.) Rydb. Conrad 49°31'N 112°00'W, 2297; (Moss 1959).

Elymus canadensis L. Aden 49°04'N 111°17'W, 1641; Big Knife 52°29'N 112°11'W, 1918; Dinosaur 50°45'N 111°34'W, 1727.

Elymus cinereus Scribn. & Merr., Writing-on-Stone 49°03'N 111°31'W, 1675; Aden 49°04'N 111°17'W, 1638; (de Vries 1968).

Elymus glaucus Buckl., Cypress Hills (Breitung 1954).

Elymus innovatus Beal, (Breitung 1954).

Elymus macounii Vasey, (U. of A. distr. map).

Elymus virginicus L., Veteran 52°15'N 111°10'W, Brinkman Aug. 2, 1926

Festuca idahoensis Elmer, (Breitung 1954; Moss 1959).

Festuca octoflora Walt., (Moss 1959).

Festuca saximontana Rydb., Provost 52°11'N 110°26'W, 423; Laurier Lake 53°50'N 110°34'W, 2028; (Breitung 1954).

Festuca scabrella Torr., Horseshoe Lake 52°21'N 110°44'W, 533; Kinsella 53°03'N 111°32'W, 1269, 1313; Onefour 49°06'N 110°36'W, 1614; (Breitung 1954).

Glyceria borealis (Nash) Batchelder, HW 41 x Battle River 53°00'N 110°52'W, 1399; Acadia Valley 51°15'N 110°13'W, 2159; Seven Persons 49°52'N 110°53'W, 2210.

Glyceria grandis S. Wats., Oyen 51°23'N 110°28'W, 733, HW 41 x Battle River 53°00'N 110°52'W, 1399, Altario 51°49'N 110°11'W, 2138. Dinosaur 50°45'N 111°34'W, 1718.

Glyceria pulchella (Nash) K. Schum., Craigmyle 51°40'N 112°20'W Brinkman, 1943.07.07

Glyceria striata (Lam.) Hitch., Dillberry Lake 52°35'N 110°01'W, 1481; Kinsella 53°03'N 111°32'W, 1296; Cypress Hills (Breitung 1954).

Helictotrichon hookeri (Scribn.) Henr., Kinsella 53°03'N 111°32'W, 1267; Halkirk 52°23'N 112°00'W, 501; Nose Hills 52°10'N 111°10'W, 558.

Hierochloe odorata (L.) Beauv., Dillberry Lake 52°35'N 110°01'W, 1449; Laurier Lake 53°50'N 110°34'W, 26; (Breitung 1954).

Hordeum brachyantherum Nevski, (Moss 1959).

Hordeum jubatum L. Dillberry Lake 52°35'N 110°01'W, 2078; Onefour 49°06'N 110°36'W, 2245.; Horseshoe Lake 52°21'N 110°44'W, 752.

Koeleria cristata (L.) Pers., Provost 52°11'N 110°26'W, 421; Dinosaur 50°45'N 111°34'W, 1211; Hand Hills 51°23'N 112°12'W; Altario 51°49'N 110°11'W, 1495.

Muhlenbergia asperifolia (Nees & Mey.) Parodi, Horseshoe Lake 52°21'N 110°44'W, 810; (Moss 1959).

Muhlenbergia cuspidata (Torr.) Rydb., Provost 52°11'N 110°26'W, 340; Kinsella 53°03'N 111°32'W, 1847; Wainwright 52°45'N 110°49'W, 389.

Muhlenbergia glomerata (Willd.) Trin., (U. of A. distr. map).

Muhlenbergia racemosa (Michx.) BSP., Big Knife 52°29'N

112°11'W, 1947.

Muhlenbergia richardsonis (Trin.) Rydb., (Moss 1959).

Munroa squarrosa (Nutt.) Torr., (Moss 1959).

Oryzopsis asperifolia Michx., Edgerton 52°45'N 110°28'W, 107; Provost 52°11'N 110°26'W, 427.

Oryzopsis hymenoides (R. & S.) Ricker, Walsh 503107'N 110°04'W, 1548; Writing-on-Stone 49°07'N 111°39'W, 1673; Wainwright 52°45'N 110°49'W, 1413.

Panicum capillare L., Brooks, (Smoliak and Johnston 1978).

Phalaris arundinacea L., Dillberry Lake 52°35'N 110°01'W, 1474; Kinsella 53°03'N 111°32'W, 1856; Dinosaur 50°45'N 111°34'W, 1720.

Phleum alpinum L., Cypress Hills (Breitung 1954; Moss 1959).

Poa arida Vasey

Poa canbyi (Scribn.) Piper, Writing-on-Stone 49°07'N 111°39'W, 1086; (Moss 1959).

Poa cusickii Vasey, (U. of A. distr. map).

Poa glaucifolia Scribn. & Will., (Breitung 1954).

Poa interior Rydb., Birch Lake 53°19'N 111°29'W, 203; Neutral Hills 52°10'N 110°51'W, 461; Dillberry Lake 52°35'N 110°01'W, 1430; Horseshoe Lake 52°21'N 110°44'W, 450.

Poa juncifolia Scribn., Halkirk 52°23'N 112°00'W, 503; Schuler 50°22'N 110°18'W, 660; Empress 50°57'N 110°01'W, 703; Grant Creek 49°28'N 110°05'W, 1583; Altario 51°49'N 110°11'W, 1495; Empress 50°57'N 110°01'W, 720; Pendant d'Oreille 49°12'N 110°53'W, 1635.

Poa nervosa (Hook.) Vasey, Cypress Hills (Breitung 1954; Moss 1959).

Poa nevadensis Vasey, Cnefour, (Smoliak and Johnston 1978).

Poa palustris L., Big Knife 52°29'N 112°11'W, 1876; Isley 53°18'N 110°33'W, 1813; Writing-on-Stone 49°07'N 111°39'W, 1704; Kinsella 53°03'N 111°32'W, 1840; Altario 51°49'N 110°11'W,1505; Hand Hills 51°23'N 112°12'W, 1762; Birch Lake 53°19'N 111°29'W, 833; Schuler 50°22'N 110°18'W, 658; Walsh 50°07'N 110°04'W, 1570.

Poa pratensis L., Big Knife 52°29'N 112°11'W, 1917; Wainwright 52°45'N 110°49'W, 1406; Schuler 50°22'N 110°18'W, 657; Writing-on-Stone 49°07'N 111°39'W, 1699; Big Knife 52°29'N 112°11'W, 1901.

Poa secunda Presl, Grant Creek 49°28'N 110°05'W, 1802; Dinosaur 50°45'N 111°34'W, 1226; (Breitung 1954).

Polypogon monspeliensis (L.) Desf., (Moss 1959).

Puccinellia cusickii Weath, Onefour, (Smoliak and Johnston 1978).

Puccinellia distans (L.) Parl., Pinhorn Grazing Res., 2379

Puccinellia nuttalliana (Schult.) Hitchc., Onefour 49°06'N 110°36'W, 1628; HW 41 x Battle River 53°00'N 110°52'W, 525; (Breitung 1954).

Schedonnardus paniculatus (Nutt.) Trel., (Moss 1959).

Scolochloa festucacea (Willd.) Link, (U. of A. distr. map).

Schizachne purpurascens (Torr.) Swallen, Dillberry Lake 52°35'N 110°01'W, 1425; HW 41 x Battle River 53°00'N 110°52'W, 1411; (Breitung 1954).
Sitanion hystrix (Nutt.) J.G. Smith, (Moss 1959).
Spartina gracilis Trin., Walsh 50°07'N 110°04'W, 1540; Tulliby Lake 53°45'N 110°11'W, 877; Seven Persons 49°52'N 110°53'W, 618; Dillberry Lake 52°35'N 110°01'W, 1462; Horseshoe Lake 52°21'N 110°44'W, 535.
Sphenopolis intermedia (Rydb.) Rydb., (Breitung 1954).
Sphenopolis obtusata (Michx.) Scribn., Gem 50°55'N 112°10'W, Hermann 13434.
Sporobolus cryptandrus (Torr.) A. Gray, Provost 52°11'N 110°26'W, 823; Orion 49°25'N 110°50'W, 2342; Dillberry Lake 52°35'N 110°01'W, 1438.
Sporobolus neglectus Nash, (Moss 1959).
Stipa columbiana Macoun, Cypress Hills (U. of A. distr. map).
Stipa comata Trin. & Rupr., Seven Persons 49°52'N 110°53'W, 592; Chappice Lake 50°09'N 110°21'W, 638; Isley 53°18'N 110°33'W, 508; Halkirk 52°23'N 112°00'W, 499; Horseshoe Lake 52°21'N 110°44'W, 530. Dillberry Lake 52°35'N 110°01'W, 322; Wainwright 52°45'N 110°49'W, 1407.
Stipa spartea Trin. var. *curtiseta* Hitchc., Dillberry Lake 52°35'N 110°01'W, 1442; Tulliby Lake 53°45'N 110°11'W, 873; Writing-on-Stone 49°07'N 111°39'W, 1713; Horseshoe Lake 52°21'N 110°44'W, 530.
Stipa viridula Trin., Aden 49°04'N 111°17'W, 1636; Schuler 50°22'N 110°18'W, 648; Neutral Hills 52°10'N 110°51'W, 465; Wainwright 52°45'N 110°49'W, 1370; Big Knife 52°29'N 112°11'W, 1899; Kinsella 53°03'N 111°32'W, 1299; Grant Creek 49°28'N 110°05'W, 1583.
Trisetum spicatum (L.) Richt., (Breitung 1954; Moss 1959).
Trisetum wolfii Vasey, Cypress Hills (Breitung 1954; Moss 1959).

CYPERACEAE

Carex aquatilis Wahlenb., Tulliby Lake 53°45'N 110°11'W, 881; Two Hills 53°40'N 111°05'W, 964, (Breitung 1954; Moss 1959).
Carex athrostachya Olney, Grant Creek 49?28'N 110?05'W, 1601.
Carex atherodes Spreng., HW 41 x Battle River 53°00'N 110°52'W, 242, Cyen 51°23'N 110°28'W, 730, Two Hills 53°40'N 111°05'W, 895, Cypress Hills (Breitung 1954).
Carex aurea Nutt., Lea Park 53°39'N 110°22'W, 840, Tulliby Lake 53°45'N 110°11'W, 886, Cypress Hills (Breitung 1954).
Carex bebbii Olney, Cypress Hills (de Vries and Bird 1968).
Carex brevior (Dewey) Mack., Schuler 50°22'N 110°18'W, 656, Big Knife 52°29'N 112°11'W, 1895.
Carex capillaris L., Cypress Hills (Breitung 1954).

Carex concinna R. Br., Laurier Lake 53°50'N 110°34'W, 15, Cypress Hills (Breitung 1954).

Carex deweyana Schwein., Cypress Hills (Breitung 1954).

Carex diandra Schrank., Cypress Hills (Breitung 1954).

Carex disperma Dewey, Cypress Hills (Breitung 1954).

Carex douglasii Boott, Writing-on-Stone 49°07'N 111°39'W, 1106; Horseshoe Lake 52°21'N 110°44'W, 540.

Carex eburnea Boott, Cypress Hills (Breitung 1954).

Carex eleocharis Bailey, (Moss 1959).

Carex festivella Mack., Cypress Hills (Breitung 1954).

Carex filifolia Nutt., Chin Coulee 49°34'N 111°52'W, 1046, Onefour 49°06'N 110°36'W, 1162, Writing-on-Stone 49°07'N 111°39'W, 1060.

Carex foenea Willd., Wainwright 52?45'N 110?49'W, 97, Dillberry Lake 52°35'N 110°01'W, 1433, Provost 52°11'N 110°26'W, 425.

Carex garberi Fern. var. *bifaria* Fern, Cypress Hills, Cormack 1945.07.24.

Carex gynocrates Wormsk., Cypress Hills (Breitung 1954).

Carex heliophila Mack. Laurier Lake 53°50'N 110°34'W, 22, Cypress Hills (Breitung 1954).

Carex hookerana Dewey, (Moss 1959).

Carex interior Bailey, Cypress Hills (Breitung 1954).

Carex lacustris Willd., Cypress Hills (Breitung 1954).

Carex lasiocarpa Ehrh. var. *americana* Fern., Empress 50°57'N 110°01'W, 726.

Carex lasiocarpa Ehrh. var. *latifolia* (Bock.) Gleason, Altario 51°49'N 110°11'W, 1509; HW 41 x Battle River 53°00'N 110°52'W, 524, Halkirk 52°23'N 112°00'W, 495, Dillberry Lake 52°35'N 110°01'W, 1459. Cypress Hills (Breitung 1954).

Carex leptalea Wahlenb., Cypress Hills (Breitung 1954).

Carex microptera Mack., Cypress Hills (Breitung 1954).

Carex nebraskensis Dewey, (Moss 1959).

Carex obtusata Lilj., Provost 52°11'N 110°26'W, 424.

Carex pachystachya Cham., Cypress Hills (Breitung 1954).

Carex platylepis Mack., Cypress Hills (de Vries and Bird 1968).

Carex praegracilis W. Boott, Tulliby Lake 53°45'N 110°11'W, 884, Walsh 50°07'N 110°04'W, 1545, Chin Coulee 49°34'N 111°52'W, 1032, Empress 50°57'N 110°01'W, 702, Cypress Hills (de Vries and Bird 1968).

Carex prairea Dewey, Cypress Hills (Breitung 1954).

Carex praticola Rydb. Halkirk 52°23'N 112°00'W, 482.

Carex richardsonii R. Br. (Moss 1959).

Carex rossii Boott; Cypress Hills, Packer 5127.

Carex rostrata Stokes, Wainwright 52°45'N 110°49'W, 220, Cypress Hills (Breitung 1954).

Carex scirpiformis Mack., Altario 51°49'N 110°11'W, 1501.

Carex simulata Mack., Cypress Hills (Breitung 1954).

Carex sprengelii Dewey, Horseshoe Lake 52°21'N 110°44'W, 544, Neutral Hills 52°10'N 110°51'W, 463, Cypress Hills (Breitung 1954).

Carex torreyi Tuckerm., Big Knife 52°29'N 112°11'W, 1885.
Carex viridula Michx., Horseshoe Lake 52°21'N 110°44'W, 818, Cypress Hills (Breitung 1954).
Carex xerantica Bailey, Vermilion, Moss 1927.08.25.
Cyperus inflexus Muhl., (Moss 1959).
Cyperus schweinitzii Torr., (Moss 1959).
Eleocharis acicularis (L.) R. & S., (Moss 1959).
Eleocharis palustris (L.) R. & S., (Breitung 1954; Moss 1959; de Vries 1968).
Eriophorum angustifolium Honckeny, Cypress Hills (Breitung 1954).
Scirpus acutus Muhl., (Breitung 1954).
Scirpus americanus Pers., (Breitung 1954; Moss 1959; de Vries 1968).
Scirpus microcarpus Presl, (Breitung 1954; Moss 1959).
Scirpus nevadensis S. Wats., (Moss 1959).
Scirpus paludosus A. Nels., (Moss 1959).
Scirpus validus Vahl, (Moss 1959).

LEMNACEAE

Lemna minor L., (Breitung 1954; Moss 1959).
Lemna trisulca L., Altario 51°49'N 110°11'W, 2176; Vermilion 53°22'N 110°53'W, 397. (Breitung 1954).

JUNCACEAE

Juncus alpinus Vill. var. *rariflorus* Hartm., Horseshoe Lake 52°21'N 110°44'W, 780.
Juncus balticus Willd., (Breitung 1954; de Vries 1968).
Juncus bufonius L., (Moss 1959).
Juncus confusus Coville, (Breitung 1954; Moss 1959).
Juncus ensifolius Wikstr., Cypress Hills (Breitung 1954; Moss 1959).
Juncus longistylis Torr., Empress 50°57'N 110°01'W, 711; Horseshoe Lake 52°21'N 110°44'W, 779; Hand Hills 51°23'N 112°12'W, 1767.
Juncus nodosus L., Hand Hills 51°23'N 112°12'W, 1763. (Breitung 1954; de Vries 1968).
Juncus saximontanus A. Nels., Cypress Hills (Breitung 1954; Moss 1959).
Juncus tenuis Willd., Big Knife 52°29'N 112°11'W, 1898; (Moss 1959).
Juncus torreyi Coville, (Moss 1959).
Juncus tracyi Rydb., Cypress Hills (de Vries and Bird 1968).
Juncus vaseyi Engelm., (U. of A. distr. map).
Luzula multiflora (Retz.) Lej., Cypress Hills (Breitung 1954).

LILIACEAE

Allium cernuum Roth, Aden 49°04'N 111°17'W, 1646; Laurier Lake 53°50'N 110°34'W, 1392; Grant Creek 49°28'N 110°05'W, 1592; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968).

Allium textile Nels. & Macbr., Horseshoe Lake 52°21'N 110°44'W, 790; Stettler 52°20'N 112°55'W, 40; HW 41 x Battle River 53°00'N 110°52'W, 402; Chin Coulee 49°34'N 111°52'W, 1035; Halkirk 52°23'N 112°00'W, 492.

Disporum trachycarpum (S. Wats.) B. & H., Lea Park 53°39'N 110°22'W, 1; Vermilion 53°22'N 110°53'W, 988; Halkirk 52°23'N 112°00'W, 486; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968).

Fritillaria pudica (Pursh) Spreng., Writing-on-Stone 49°07'N 111°39'W; (de Vries 1968).

Lilium philadelphicum L. var. *andinum* (Nutt.) Ker, Altario 51°49'N 110°11'W, 2127; Kinsella 53°03'N 111°32'W, 1322; Isley 53°18'N 110°33'W, 509; Dillberry Lake 52°35'N 110°01'W, 1419; Horseshoe Lake 52°21'N 110°44'W, 777; Hand Hills 51°23'N 112°12'W, 563.

Maianthemum canadense Desf. var. *interius* Fern, Big Knife 52°29'N 112°11'W, 1916; Edgerton 52°45'N 110°28'W, 105; Lea Park 53°39'N 110°22'W, 838;

Smilacina racemosa (L.) Desf. var. *amplexicaulis*, Hand Hills 51°23'N 112°12'W, 1238; Writing-on-Stone 49°07'N 111°39'W; (de Vries 1968); Cypress Hills (Breitung 1954).

Smilacina stellata (L.) Desf., Stettler 52°20'N 112°55'W, 46; Writing-on-Stone 49°07'N 111°39'W, 1072; Edgerton 52°45'N 110°28'W, 307; Dillberry Lake 52°35'N 110°01'W, 1421; Lea Park 53°39'N 110°22'W, 5; Empress 50°57'N 110°01'W, 681; HW 41 x Battle River 53°00'N 110°52'W, 79; Neutral Hills 52°10'N 110°51'W, 462; Battle R. x HW 36 52°25'N 111°49'W, 1022; Camrose 53°05'N 112°57'W, 52.

Smilacina trifolia (L.) Desf. Elk Point 53°55'N 110°50'W, 363; Laurier Lake 53°50'N 110°34'W, 385.

Streptopus amplexifolius (L.) DC., Cypress Hills (Breitung 1954).

Tofieldia glutinosa (Michx.) Pers., Wainwright 52°45'N 110°49'W, 229, 1355.

Yucca glauca Nutt., Onefour 49°06'N 110°36'W, 2236; (Moss 1959).

Zygadenus elegans Pursh, Kinsella 53°03'N 111°32'W, 1787; Hand Hills 51°23'N 112°12'W, 562; Horseshoe Lake 52°21'N 110°44'W, 814; Lea Park 53°39'N 110°22'W, 842; Wainwright 52°45'N 110°49'W, 1403; Dillberry Lake 52°35'N 110°01'W, 1418.

Zygadenus gramineus Rydb., Schuler 50°22'N 110°18'W, 653; Onefour 49°06'N 110°36'W, 1164; Hand Hills 51°23'N 112°12'W, 1265; Chin Coulee 49°34'N 111°52'W, 1041; Altario 51°49'N 110°11'W, 2134.

IRIDACEAE

Sisyrinchium montanum Greene, Altario 51°49'N 110°11'W, 2114; Dillberry Lake 52°35'N 110°01'W, 2061; Horseshoe Lake 52°21'N 110°44'W, 444; Wainwright 52°45'N 110°49'W, 91; Halkirk 52°23'N 112°00'W, 475; Edgerton 52°45'N 110°28'W, 407.

ORCHIDACEAE

Calypso bulbosa (L.) Oakes, Cypress Hills (Breitung 1954; Moss 1959).

Corallorhiza maculata Raf., Cypress Hills (de Vries and Bird 1968).

Corallorhiza striata Lindl. Cypress Hills (Breitung 1954; Moss 1959).

Corallorhiza trifida Chatelain, Cypress Hills (de Vries and Bird 1968).

Cypripedium calceolus L. var. *pubescens* (Willd.) Corell, Lea Park 53°39'N 110°22'W, 843; Elk Point 53°55'N 110°50'W, 357.

Cypripedium passerinum Richards., Tulliby Lake 53°45'N 110°11'W, 862; Cypress Hills (Breitung 1954).

Habenaria dilatata (Pursh) Hook., Cypress Hills (U. of A. distr. map).

Habenaria hyperborea (L.) R. Br., Dillberry Lake 52°35'N 110°01'W, 1458; Tulliby Lake 53°45'N 110°11'W, 859; Wainwright 52°45'N 110°49'W, 1366; Kinsella 53°03'N 111°32'W, 1785; Horseshoe Lake 52°21'N 110°44'W, 766; Altario 51°49'N 110°11'W, 1513; Cypress Hills (Breitung 1954).

Habenaria obtusata (Pursh) Richards., Elk Point 53°55'N 110°50'W, 364; Cypress Hills (Breitung 1954).

Habenaria viridis (L.) R. Br. var. *bracteata* (Muhl.) A. Gray, Lea Park 53°39'N 110°22'W, 845; Cypress Hills (Breitung 1954).

Listera borealis Morcng, Cypress Hills (Breitung 1954).

Malaxis brachyopoda (A. Gray) Fern., Birch Lake 53°19'N 111°29'W, 204.

Orchis rotundifolia Banks, Cypress Hills (Breitung 1954).

Spiranthes romanzoffiana Cham. & Schl., Horseshoe Lake 52°21'N 110°44'W, 815; Tulliby Lake 53°45'N 110°11'W, 858; Cypress Hills (Breitung 1954).

SALICACEAE

Populus acuminata Rydb., (Moss 1959).

Populus balsamifera L., Cypress Hills (Breitung 1954).

Populus sargentii Dode, Empress 50°57'N 110°01'W, 707; Dinosaur 50°45'N 111°34'W, 1189; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968).

Populus tremuloides Michx., Schuler 50°22'N 110°18'W, 662; Cypress Hills (Breitung 1954).

Salix amygdaloides Anderss., S. Sask. Riv. x HW 41 50°44'N 110°05'W, 667; Writing-on-Stone 49°07'N 111°39'W, 1074, 1075; Cypress Hills (Breitung 1954).

Salix bebbiana Sarg., Neutral Hills 52°10'N 110°51'W, 460; Hand Hills 51°23'N 112°12'W, 565; Kinsella 53°03'N 111°32'W, 1009; Big Knife 52°29'N 112°11'W, 1906.

Salix brachycarpa Nutt., Kinsella 53°03'N 111°32'W, 1289.

Salix candida Fluegge, Laurier Lake 53°50'N 110°34'W, 378; Kinsella 53°03'N 111°32'W, 1289; Cypress Hills (Breitung 1954).

Salix discolor Muhl., (Breitung 1954).

Salix drummondiana Barratt, Cypress Hills (Breitung 1954).

Salix fluviatilis Nutt., Onefour, (Smoliak and Johnston 1978).

Salix interior Rowlee, Neutral Hills 52°10'N 110°51'W, 457; S. Sask. Riv. x HW 41 50°44'N 110°05'W, 665; Battle R. x HW 36 52°25'N 111°49'W, 1025, 1026; Seven Persons 49°52'N 110°53'W, 1188; Walsh 50°07'N 110°04'W, 1572.

Salix lutea Nutt., Battle R. x HW 36 52°25'N 111°49'W, 1023; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968).

Salix maccalliana Rowlee, Cypress Hills (Breitung 1954).

Salix myrtillifolia Anderss., Cypress Hills (Breitung 1954).

Salix petiolaris J. E. Sm., Craigmyle 51°40'N 112°20'W Brinkman, June 4, 1922

Salix planifolia Pursh, Cypress Hills (de Vries and Bird 1968).

Salix pseudocordata (Anderss.) Rydb., Cypress Hills (Breitung 1954).

Salix pseudomonticola Ball, Walsh 50°07'N 110°04'W, 1572; Cypress Hills (Breitung 1954).

Salix scouleriana Barratt, Tulliby Lake 53°45'N 110°11'W, 888; Cypress Hills (Breitung 1954).

Salix serissima (Bailey) Fern., (Breitung 1954).

BETULACEAE

Alnus crispa (Ait.) Pursh, Laurier Lake 53°50'N 110°34'W, 28; Elk Point 53°55'N 110°50'W, 362.

Alnus tenuifolia Nutt., Big Knife 52°29'N 112°11'W, 1912.

Betula occidentalis Hook, Brooks, Moss 10385.

Betula papyrifera Marsh, Wainwright (site record).

Corylus cornuta Marsh. Laurier Lake 53°50'N 110°34'W, 133; Elk Point 53°55'N 110°50'W, 360; Big Knife 52°29'N 112°11'W, 1942.

URTICACEAE

Parietaria pensylvanica Muhl., Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968).

Urtica gracilis Ait., Vermilion (site rec.), common (Moss 1959; de Vries 1968).

SANTALACEAE

Comandra pallida A. DC., Lea Park 53°39'N 110°22'W, 4; Writing-on-Stone 49°07'N 111°39'W, 1061; Horseshoe Lake 52°21'N 110°44'W, 759; HW 41 x Battle River 53°00'N 110°52'W, 89; Stettler 52°20'N 112°55'W, 36; Seven Persons 49°52'N 110°53'W, 2204; Cypress Hills (Breitung 1954).

Geocaulon lividum (Richards.) Fern., Elk Point 53°55'N 110°50'W, 358.

LORANTHACEAE

Arceuthobium americanum Nutt., Cypress Hills (Breitung 1954).

POLYGONACEAE

Eriogonum cernuum Nutt., Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968).

Eriogonum flavum Nutt., Writing-on-Stone 49°07'N 111°39'W, 1683; Hand Hills 51°23'N 112°12'W, 574; Dinosaur 50°45'N 111°34'W, 1199; Seven Persons 49°52'N 110°53'W, 584; Empress 50°57'N 110°01'W, 1530; Grant Creek 49°28'N 110°05'W, 1588.

Polygonum achoreum Blake, (U. of A. distr. map).

Polygonum amphibium L. var. *stipulaceum* (Coleman) Fern., Vermilion 53°22'N 110°53'W, 396;

Polygonum aviculare L., Seven Persons 49°52'N 110°53'W, 626; Conrad 49°31'N 112°00'W, 2293. (Moss 1959).

Polygonum bistortoides Pursh, Cypress Hills (Breitung 1954; Moss 1959).

Polygonum coccineum Muhl. Walsh 50°07'N 110°04'W, 1568; Vermilion 53°22'N 110°53'W, 230; Seven Persons 49°52'N 110°53'W, 603; Cypress Hills (Breitung 1954).

Polygonum douglasii Greene, (Breitung 1954; Moss 1959).

Polygonum erectum L., (Smoliak and Johnston 1978).

Polygonum interior Brenckle, (Moss 1959).

Polygonum lapathifolium L., HW 41 x Battle River 53°00'N 110°52'W, 238; S. Sask. Riv. x HW 41 50°44'N 110°05'W, 2182; Seven Persons 49°52'N 110°53'W, 2223.

Polygonum ramosissimum Michx., Orion 49°25'N 110°50'W, 2231; Conrad 49°31'N 112°00'W, 2291; Dillberry Lake 52°35'N 110°01'W, 1472; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968).

Polygonum watsonii Small, (Moss 1959).

Rumex maritimus L. var *fueginus* (Phil.) Dusen, Wildhorse 49°01'N 110°15'W, 2265; Conrad 49°31'N 112°00'W, 2308; S. Sask. Riv. x HW 41 50°44'N 110°05'W, 2184.

Rumex mexicanus Meisn., Dillberry Lake 52°35'N 110°01'W, 2074; Acadia Valley 51°15'N 110°13'W, 2162; Seven Persons 49°52'N 110°53'W, 2212; Grant Creek 49°28'N 110°05'W, 1582; Wildhorse 49°01'N 110°15'W, 2255.

* *Rumex venosus* Pursh, Seven Persons 49°52'N 110°53'W, 1187; Horseshoe Lake 52°21'N 110°44'W, 419; Writing-on-Stone 49°07'N 111°39'W, 1050.

CHENOPODIACEAE

Atriplex argentea Nutt., Onefour 49°06'N 110°36'W, 2287; (Moss 1959).

Atriplex nuttallii S. Wats., Kinsella 53°03'N 111°32'W, 1852; Seven Persons 49°52'N 110°53'W, 597; Dinosaur 50°45'N 111°34'W, 1190; Writing-on-Stone 49°07'N 111°39'W, 1680; Onefour 49°06'N 110°36'W, 1136; Big Knife 52°29'N 112°11'W, 1933.

Atriplex patula var. *hastata* (L.) A. Gray, Pendant d'Oreille 49°12'N 110°53'W, 2290, 2367.

Atriplex powellii Wats., (Smoliak and Johnston 1978).

Atriplex truncata (Torr.) Gray, (Smoliak and Johnston 1978).

Chenopodium berlandieri Moq. var. *farinosum* (Ludwig) Aellen (Moss 1959).

Chenopodium capitatum (L.) Aschers., (Moss 1959).

Chenopodium fremontii S. Wats., Orion 49°25'N 110°50'W, 23288, 2348; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968).

Chenopodium glaucum L. ssp. *salinum* (Standl.) Aellen, S. Sask. Riv. x HW 41 50°44'N 110°05'W, 2183; Orion 49°25'N 110°50'W, 2332; Wildhorse 49°01'N 110°15'W 2257; Conrad 49°31'N 112°00'W, 2301; Pendant d'Oreille 49°12'N 110°53'W, 2368.

Chenopodium hybridum L. var. *gigantospermum* (Aellen) Rouleau, (Moss 1959).

Chenopodium leptophyllum Nutt., Altario 51°49'N 110°11'W, 2172; (Moss 1959).

Chenopodium pratericola Rydb., Onefour 49°06'N 110°36'W, 2249; Orion 49°25'N 110°50'W, 2329.

Chenopodium rubrum L. var. *humile* (Hook.) S. Wats., Wildhorse 49°01'N 110°15'W, 2256.

Corispermum hyssopifolium L., (U. of A. distr. map).

Corispermum orientale Lam. var. *emarginatum* (Rydb.) Macbr., (Moss 1959).

Endolepis suckleyi Torr., Seven Persons 49°52'N 110°53'W, 2218; Pendant d'Oreille 49°12'N 110°53'W, 2357. Dinosaur 50°45'N 111°34'W, 1224.

Eurotia lanata (Pursh) Moq., Dinosaur 50°045'N 111°34'W, 1741; Chin Coulee 49°34'N 111°52'W, 1048; Writing-on-Stone 49°07'N 111°39'W, 1068; S. Sask. Riv. x HW 41 50°44'N 110°05'W, 2186; Altario 51°49'N 110°11'W, 2168.

Kochia scoparia (L.) Schrad., Acadia Valley 51°15'N 110°13'W, 2150; Wildhorse 49°01'N 110°15'W, 2258; Seven Persons 49°52'N 110°53'W, 2219; Onefour 49°06'N 110°36'W, 2248.

Monolepis nuttalliana (Schultes) Greene, Onefour 49°06'N 110°36'W, 1135.

Salicornia rubra A. Nels. Wainwright 52°45'N 110°49'W, 2008.

Sarcobatus vermiculatus (Hook.) Torr., Orion 49°25'N 110°50'W, 2333; Onefour 49°06'N 110°36'W, 1137, 2239; S. Sask. Riv. x HW 41 50°44'N 110°05'W, 663; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968).
Suaeda depressa (Pursh.) S. Wats., S. Sask. Riv. x HW 41 50°44'N 110°05'W, 2188; Orion 49°25'N 110°50'W, 2230; Wainwright 52°45'N 110°49'W, 2009; Tulliby Lake 53°45'N 110°11'W, 865; Chappice Lake 50°09'N 110°21'W, 642; Horseshoe Lake 52°21'N 110°44'W, 804.
Suckleya suckleyana (Torr.) Rydb., (Moss 1959).

AMARANTHACEAE

Amaranthus albus L., (U. of A. distr. map).

NYCTAGINACEAE

Abronia micrantha Torr., Onefour 49°06'N 110°36'W, (Smoliak and Johnston 1978).
Mirabilis hirsuta (Pursh.) MacM., Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968).
Mirabilis nyctaginea (Michx.) MacM., (Moss 1959).

PORTULACACEAE

Claytonia lanceolata Pursh, Cypress Hills (Moss 1959).
Montia linearis (Dougl.) Greene, (Moss 1959).

CARYOPHYLLACEAE

Arenaria congesta Nutt. var. *lithophila* (Rydb.) Maguire (Breitung 1954; Moss 1959).
Arenaria lateriflora L., Horseshoe Lake 52°21'N 110°44'W, 413; Vermilion 53°22'N 110°53'W, 983; Kinsella 53°03'N 111°32'W, 1278; Cypress Hills (de Vries and Bird 1968).
Arenaria rubella (Whalenb.) J. E. Sm., Cypress Hills (Breitung 1954).
Cerastium arvense L., Onefour 49°06'N 110°36'W, 2286; Writing-on-Stone 49°07'N 111°39'W, 1091; Lea Park 53°39'N 110°22'W, 172; Hand Hills 51°23'N 112°12'W, 1247; Vermilion 53°22'N 110°53'W, 76; Kinsella 53°03'N 111°32'W, 1005.
Lychnis drummondii (Hook.) S. Wats., Orion 49°25'N 110°50'W, 2325.
Paronychia sessiliflora Nutt., Writing-on-Stone 49?07'N 111°39'W, (de Vries 1968); (Moss 1959).
Silene menziesii Hook., Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968).
Spergularia marina (L.) Griseb. var. *leiosperma* (Kindb.) Gurke, (Moss 1959).
Stellaria calycantha Ledeb.) Bong., (Moss 1959).
Stellaria crassifolia Ehrh., (Moss 1959).
Stellaria longifolia Muhl., Kinsella 53°03'N 111°32'W, 278;

Stellaria longipes Goldie, Acadia Valley 51°15'N 110°13'W, 2157; Dillberry Lake 52°35'N 110°01'W, 2056; Altario 51°49'N 110°11'W, 1510; Edgerton 52°45'N 110°28'W, 118; Hand Hills 51°23'N 112°12'W, 1249; Vermilion 53°22'N 110°53'W, 78; Dillberry Lake 52°35'N 110°01'W, 1431.

NYMPHACEAE

Nuphar variegatum Engelm, Wainwright 52°45'N 110°49'W, 224.

CERATOPHYLLACEAE

Ceratophyllum demersum L., (Moss 1959).

RANUNCULACEAE

Actaea rubra (Ait.) Willd., Dillberry Lake 52°35'N 110°01'W, 2052; Hand Hills 51°23'N 112°12'W, 569; Halkirk 52°23'N 112°00'W, 489; Wainwright 52°45'N 110°49'W, 215.

Anemone canadensis L., Dillberry Lake 52°35'N 110°01'W, 2107; HW 41 x Battle River 53°00'N 110°52'W, 1343; Provost 52°11'N 110°26'W, 826; Kinsella 53°03'N 111°32'W, 1315; Neutral Hills 52°10'N 110°51'W, 467.

Anemone cylindrica A. Gray, Altario 51°49'N 110°11'W, 1508; Wainwright 52°45'N 110°49'W, 951; Big Knife 52°29'N 112°11'W, 1907; Dillberry Lake 52°35'N 110°01'W, 1428.

Anemone multifida Poir., Kinsella 53°03'N 111°32'W, 1272; Halkirk 52°23'N 112°00'W, 504; Altario 51°49'N 110°11'W, 1507; Hand Hills 51°23'N 112°12'W, 1250.

Anemone patens L. var. *wolfgangiana* (Bess.) Koch, Lea Park 53°39'N 110°22'W, 2; Big Knife 52°29'N 112°11'W, 61.

Caltha natans Pall., Wainwright 52°45'N 110°49'W, 249.

Clematis ligusticifolia Nutt., Writing-on-Stone 49°07'N 111°39'W, 1081; S. Sask. Riv. x HW 41 50°44'N 110°05'W, 2404; Pendant d'Oreille 49°12'N 110°53'W, 2355.

Clematis verticillaris DC. var. *columbiana* (Nutt.) A. Gray, (Breitung 1954).

Delphinium bicolor Nutt., Writing-on-Stone 49°07'N 111°39'W, 1111; Cypress Hills (de Vries and Bird 1968).

Myosorus aristatus Benth. ssp. *montanus* (Campbell) Stone, Onefour 49°06'N 110°36'W, (Smoliak and Johnston 1978).

Myosorus minimus L. Chin Coulee 49°34'N 111°52'W, 1038.

Ranunculus abortivus L., (Moss 1959).

Ranunculus acris L. (Breitung 1954; Moss 1959).

Ranunculus aquatilis L. var. *capillaceus* (Thuill.) DC., Acadia Valley 51°15'N 110°13'W, 2147; Seven Persons 49°52'N 110°53'W, 614.

Ranunculus cardiophyllus Hook., (Moss 1959; de Vries and Bird 1968).

Ranunculus circinatus Sibth. var. *subrigidus* (W. Drew) L. Benson (Moss 1959).

Ranunculus cymbalaria Pursh, S. Sask. Riv. x HW 41 50°44'N 110°05'W, 2185; Dillberry Lake 52°35'N 110°01'W, 1473;

Horseshoe Lake 52°21'N 110°44'W, 802; HW 41 x Battle River 53°00'N 110°52'W, 1337; Provost 52°11'N 110°26'W, 433; Walsh 50°07'N 110°04'W, 1541; Tulliby Lake 53°45'N 110°11'W, 868; Writing-on-Stone 49°07'N 111°39'W, 1110; Edgerton 52°45'N 110°28'W, 117; Kinsella 53°03'N 111°32'W, 1294.

Ranunculus flammula L., Northeastern parkland (U. of A. distr. map).

Ranunculus glaberrimus Hook., (Moss 1959).

Ranunculus gmelinii DC., Cypress Hills (de Vries and Bird 1968).

Ranunculus inamoenus Greene, Cypress Hills (Breitung 1954; Moss 1959).

Ranunculus macounii Britt., Dillberry Lake 52°35'N 110°01'W, 2063; Oyen 51°23'N 110°28'W, 734; Altario 51°49'N 110°11'W, 1515; Hand Hills 51°23'N 112°12'W, 1758; Birch Lake 53°19'N 111°29'W, 832.

Ranunculus pedatifidus J.E. Smith var. *affinis* (R. Br.) L. Benson, Kinsella 53°03'N 111°32'W, 1279; Halkirk 52°23'N 112°00'W, 474; Cypress Hills (Breitung 1954).

Ranunculus rhomboideus Goldie, Big Knife 52°29'N 112°11'W, 59; (Moss 1959).

Ranunculus sceleratus L., Dillberry Lake 52°35'N 110°01'W, 1468; Edgerton 52°45'N 110°28'W, 115; Kinsella 53°03'N 111°32'W, 1353.

Thalictrum dasycarpum Fisch. & Ave-Lall., (Breitung 1954).

Thalictrum occidentale A. Gray, Cypress Hills (Breitung 1954 Moss 1959).

Thalictrum venulosum Trel., Battle R. x HW 36 52°25'N 111°49'W, 1021; Stettler 52°20'N 112°55'W, 71; Edgerton 52°45'N 110°28'W, 110; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968).

FUMARIACEAE

Corydalis aurea Willd. Lea Park 53°39'N 110°22'W, 6; Vermilion 53°22'N 110°53'W, 985; Edgerton 52°45'N 110°28'W, 122; Battle R. x HW 36 52°25'N 111°49'W, 1018.

CRUCIFERAE

Arabis divaricarpa A. Nels., Hand Hills 51°23'N 112°12'W, 1253; Stettler 52°20'N 112°55'W, 68; Cypress Hills (de Vries and Bird 1968).

Arabis drummondii A. Gray, Cypress Hills (Breitung 1954).

Arabis glabra (L.) Bernh., Cypress Hills (Breitung 1954).

Arabis hirsuta (L.) Scop. *pycnocarpa* (Hopkins) Rollins, Halkirk 52°23'N 112°00'W, 498.

Arabis holboellii Hornem., Laurier Lake 53°50'N 110°34'W, 25; Onefour 49°06'N 110°36'W, 1156.

Arabis lyrata L., Clandonald 53°35'N 110°45'W, 747. (Cypress Hills).

Cardamine pensylvanica Muhl., Cypress Hills (de Vries and Bird 1968).

Descurainia pinnata (Walt.) Britt. var. *brachycarpa* (Walt.) Britt., (Moss 1959; de Vries 1968).

Descurainia richardsonii (Sweet) O.E. Schulz, Dillberry Lake 52°35'N 110°01'W, 2103; (Moss 1959).

Draba nemorosa L., Vermilion 53°22'N 110°53'W, 1000; Chin Coulee 49°34'N 111°52'W, 1039.

Erysimum asperum (Nutt.) DC., Dillberry Lake 52°35'N 110°01'W, 1450; Wainwright 52°45'N 110°49'W, 92; Edgerton 52°45'N 110°28'W, 403.

Erysimum cheiranthoides L., Dillberry Lake 52°35'N 110°01'W, 2105; HW 41 x Battle River 53°00'N 110°52'W, 1332; Neutral Hills 52°10'N 110°51'W, 461; Big Knife 52°29'N 112°11'W, 1921; Grant Creek 49°28'N 110°05'W, 1559; Hand Hills 51°23'N 112°12'W, 1776.

Erysimum inconspicuum (S. Wats.) MacM., Altario 51°49'N 110°11'W, 2166, 2121; Dinosaur 50°45'N 111°34'W, 1202; Isley 53°18'N 110°33'W, 516; Grant Creek 49°28'N 110°05'W, 1578; Empress 50°57'N 110°01'W, 715; Kinsella 53°03'N 111°32'W, 1281; Horseshoe Lake 52°21'N 110°44'W, 537; Altario 51°49'N 110°11'W, 1494; Chin Coulee 49°34'N 111°52'W, 1115; Writing-on-Stone 49°07'N 111°39'W, 1689.

Lepidium densiflorum Schrad., Big Knife 52°29'N 112°11'W, 1893; Dillberry Lake 52°35'N 110°01'W, 2100; Dinosaur 50°45'N 111°34'W, 1227; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968).

Lepidium ramosissimum A. Nels., Dinosaur 50°45'N 111°34'W, 1194.

Lesquerella alpina (Nutt). S. Wats. var. *spathulata* (Rydb.) Payson, Writing-on-Stone 49°07'N 111°39'W, 1056, 1093.

Lesquerella arenosa (Richards.) Rydb., Stettler 52°20'N 112°55'W, 42; Hand Hills 51°23'N 112°12'W, 1240; Writing-on-Stone 49°07'N 111°39'W, 1150.

Rorippa islandica (Oeder) Borbas, Dillberry Lake 52°35'N 110°01'W, 2070; Wildhorse 49°01'N 110°15'W, 2070; Big Knife 52°29'N 112°11'W, 1922; Dillberry Lake 52°35'N 110°01'W, 315; Birch Lake 53°19'N 111°29'W, 835; Oyen 51°23'N 110°28'W, 731.

Rorippa obtusata (Nutt.) Britt., Conrad 49°31'N 112°00'W, 2305.

Rorippa sinuata (Nutt.) Hitchc., (Moss 1959).

CAPPARIDACEAE

Cleome serrulata Pursh, Monitor, 2410; Writing-on-Stone 49°07'N 111°39'W, 1690; Empress 50°57'N 110°01'W, 688; Altario 51°49'N 110°11'W, 1521.

Polanisia trachysperma T. & G., (Moss 1959).

CRASSULACEAE

Sedum stenopetalum Pursh, Cypress Hills (Moss 1959).

SAXIFRAGACEAE

Heuchera cylindrica Dougl., Cypress Hills (U. of A. distr. map).

Heuchera flagellifolia Rydb., (Breitung 1954; Moss 1959).

Heuchera parvifolia, Cypress Hills, Cormack 391.

Heuchera richardsonii R. Br., Kinsella 53°03'N 111°32'W, 1318; Isley 53°18'N 110°33'W, 1816; Seven Persons 49°52'N 110°53'W, 580; HW 41 x Battle River 53°00'N 110°52'W, 1333; Wainwright 52°45'N 110°49'W, 102, 1615; Dillberry Lake 52°35'N 110°01'W, 1445; Halkirk 52°23'N 112°00'W, 470; Horseshoe Lake 52°21'N 110°44'W, 445.

Mitella nuda L., Cypress Hills (de Vries and Bird 1968).

Parnassia palustris L. var. *neogaea* Fern., Horseshoe Lake 52°21'N 110°44'W, 771; Altario 51°49'N 110°11'W, 1500; Kinsella 53°03'N 111°32'W, 1786; Wainwright 52°45'N 110°49'W, 244.

Ribes americanum Mill., Dillberry Lake 52°35'N 110°01'W, 2049; Vermilion 53°22'N 110°53'W, 984; Stettler 52°20'N 112°55'W, 45; Kinsella 53°03'N 111°32'W, 1015.

Ribes aureum Pursh, Pinhorn grazing res. stn., 49°07'N 110°53'W, 2370; Writing-on-Stone 49°07'N 111°39'W, 1089; Cypress Hills (Breitung 1954).

Ribes hudsonianum Richards, Cypress Hills (de Vries 1968).

Ribes lacustre (Pers.) Poir., Cypress Hills (Breitung 1954).

Ribes oxyacanthoides L., Hand Hills 51°23'N 112°12'W, 1261; Empress 50°57'N 110°01'W, 678; Dinosaur 50°45'N 111°34'W, 1204; Stettler 52°20'N 112°55'W, 32; Neutral Hills 52°10'N 110°51'W, 458; Horseshoe Lake 52°21'N 110°44'W, 758.

Ribes setosum Lindl., Castor 52°13'N 111°53'W, Moss 10365.

Saxifraga occidentalis S. Wats., (U. of A. distr. map).

ROSACEAE

Agrimonia striata Michx., Big Knife 52°29'N 112°11'W, 1900; Wainwright 52°45'N 110°49'W, 213; Birch Lake 53°19'N 111°29'W, 831; Vermilion 53°22'N 110°53'W, 232; Cypress Hills (de Vries and Bird 1968).

Amelanchier alnifolia Nutt., Seven Persons 49°52'N 110°53'W, 2119; Dillberry Lake 52°35'N 110°01'W, 2054; Kinsella 53°03'N 111°32'W, 1014; Cypress Hills (de Vries and Bird 1968).

Chamaerhodos erecta (L.) Bunge ssp. *nuttallii* (Pickering) Hultén, Dillberry Lake 52°35'N 110°01'W, 2090; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968).

Crataegus columbiana Howell, Cypress Hills (Breitung 1954).

Crataegus chrysocarpa Ashe, Writing-on-Stone 49°07'N 111°39'W, 1078; Battle R. x HW 36 52°25'N 111°49'W, 1019; Stettler 52°20'N 112°55'W, 47; Cypress Hills (de Vries and Bird 1968).

Crataegus douglasii Lindl., Cypress Hills (Moss 1959).

Fragaria virginiana Duchesne, Seven Persons 49°52'N 110°53'W, 2196; HW 41 x Battle River 53°00'N 110°52'W, 80; Halkirk 52°23'N 112°00'W, 491; Kinsella 53°03'N 111°32'W, 1002.

Geum aleppicum Jacq. var. *strictum* (Ait.) Fern., Dillberry Lake 52°35'N 110°01'W, 1496; HW 41 x Battle River 53°00'N 110°52'W, 1341; Horseshoe Lake 52°21'N 110°44'W, 540; Kinsella 53°03'N 111°32'W, 1327.

Geum macrophyllum Willd. var. *perincisum* (Rydb.) Raup, Cypress Hills (de Vries and Bird 1968).

Geum rivale L., Cypress Hills (Breitung 1954).

Geum triflorum Pursh, Seven Persons 49°52'N 110°53'W, 1171; Lea Park 53°39'N 110°22'W, 3; Writing-on-Stone 49°07'N 111°39'W, 1119; Halkirk 52°23'N 112°00'W, 471; Hand Hills 51°23'N 112°12'W, 1234; HW 41 x Battle River 53°00'N 110°52'W, 82; Onefour 49°06'N 110°36'W, 1146; Empress 50°57'N 110°01'W, 677; Dinosaur 50°45'N 111°34'W, 1198; Kinsella 53°03'N 111°32'W, 1016.

Potentilla anserina L., Altario 51°49'N 110°11'W, 2129; Wildhorse 49°01'N 110°15'W, 2270; Dillberry Lake 52°35'N 110°01'W, 1476; Edgerton 52°45'N 110°28'W, 121; HW 41 x Battle River 53°00'N 110°52'W, 1338; Writing-on-Stone 49°07'N 111°39'W, 1082; Lea Park 53°39'N 110°22'W, 848; Kinsella 53°03'N 111°32'W, 1291; Horseshoe Lake 52°21'N 110°44'W, 441.

Potentilla arguta Pursh, Tulliby Lake 53°45'N 110°11'W, 880; Isley 53°18'N 110°33'W, 1828; HW 41 x Battle River 53°00'N 110°52'W, 237; Kinsella 53°03'N 111°32'W, 1318; Writing-on-Stone 49°07'N 111°39'W, 1693; Big Knife 52°29'N 112°11'W, 1926; Grant Creek 49°28'N 110°05'W, 1587.

Potentilla bipinnatifida Dougl. Kinsella 53°03'N 111°32'W, 1857; Cypress Hills (Breitung 1954).

Potentilla concinna Richards., Writing-on-Stone 49°07'N 111°39'W, 1697; Stettler 52°20'N 112°55'W, 64; Cypress Hills (Breitung 1954).

Potentilla diversifolia Lehm., Cypress Hills (Breitung 1954).

Potentilla effusa Dougl., (Moss 1959; de Vries 1968).

Potentilla finitima Kohli & Packer, Hardisty, Kohli B.K. 1972-55a

Potentilla fruticosa L., Cypress Hills (Breitung 1954).

Potentilla gracilis Dougl. var. *flabelliformis* (Lehm.) Nutt., Altario 51°49'N 110°11'W, 1499; Dillberry Lake 52°35'N 110°01'W, 1484.

Potentilla gracilis Dougl. var. *pulcherrima* (Lehm.) Fern., Hand Hills 51°23'N 112°12'W, 564; Wainwright 52°45'N 110°49'W, 1404; Big Knife 52°29'N 112°11'W, 1950; Kinsella 53°03'N 111°32'W, 1300; Cypress Hills (Breitung 1954).

Potentilla gracilis Dougl. var. *rigida* (Nutt.) S. Wats., Schuler 50°22'N 110°18'W, 651; Writing-on-Stone 49°07'N 111°39'W, 1695; Halkirk 52°23'N 112°00'W, 494; Big Knife 52°29'N 112°11'W, 1908; Grant Creek 49°28'N 110°05'W, 1585.

Potentilla hippiana Lehm., Horseshoe Lake 52°21'N 110°44'W, 437; Onefour 49°06'N 110°36'W, 1152; Horseshoe Lake 52°21'N 110°44'W, 791; Isley 53°18'N 110°33'W, 1819; Kinsella 53°03'N 111°32'W, 1306; Writing-on-Stone 49°07'N 111°39'W, 1694.

Potentilla norvegica L., Provost 52°11'N 110°26'W, 351; Kinsella 53°03'N 111°32'W, 1867; Hand Hills 51°23'N 112°12'W, 1759; Big Knife 52°29'N 112°11'W, 1905.

Potentilla paradoxa Nutt., S. Sask. Riv. x HW 41 50°44'N 110°05'W, 2187; Wildhorse 49°01'N 110°15'W, 2261.

Potentilla pensylvanica L., Dillberry Lake 52°35'N 110°01'W, 2083; Altario 51°49'N 110°11'W, 2117; Orion 49°25'N 110°50'W, 2315; Wainwright 52°45'N 110°49'W, 1373; Empress 50°57'N 110°01'W, 716; Tulliby Lake 53°45'N 110°11'W, 883; Horseshoe Lake 52°21'N 110°44'W, 800; Big Knife 52°29'N 112°11'W, 1889; Grant Creek 49°28'N 110°05'W, 1577; Writing-on-Stone 49°07'N 111°39'W, 1696.

Prunus pensylvanica L.f., Vermilion 53°22'N 110°53'W, 987; Horseshoe Lake 52°21'N 110°44'W, 808; Cypress Hills (de Vries and Bird 1968).

Prunus virginiana L., Orion 49°25'N 110°50'W, 2316; Writing-on-Stone 49°07'N 111°39'W, 1076; Hand Hills 51°23'N 112°12'W, 1235; Wainwright 52°45'N 110°49'W, 90; Empress 50°57'N 110°01'W, 677; Neutral Hills 52°10'N 110°51'W, 466; Edgerton 52°45'N 110°28'W, 909; Battle R. x HW 36 52°25'N 111°49'W, 1024.

Rosa acicularis Lindl., Kinsella 53°03'N 111°32'W, 1274; Horseshoe Lake 52°21'N 110°44'W, 411; Dillberry Lake 52°35'N 110°01'W, 1439; Cypress Hills (Breitung 1954).

Rosa arkansana Porter, Seven Persons 49°52'N 110°53'W, 2197; Dillberry Lake 52°35'N 110°01'W, 2098; Schuler 50°22'N 110°18'W, 645.

Rosa woodsii Lindl. Conrad 49°31'N 112°00'W, 2310; Kinsella 53°03'N 111°32'W, 1350; Horseshoe Lake 52°21'N 110°44'W, 785; Cypress Hills (Breitung 1954).

Rubus acaulis Michx., northeastern parkland (U. of A. distr. map).

Rubus parviflorus Nutt., Cypress Hills (Moss 1959).

Rubus pubescens Raf., Kinsella 53°03'N 111°32'W, 1008; Lea Park 53°39'N 110°22'W, 165; Cypress Hills (de Vries and Bird).

Rubus strigosus Michx., Kinsella 53°03'N 111°32'W, 1277; Neutral Hills 52°10'N 110°51'W, 459; Cypress Hills (de Vries and Bird).

Spirea alba Du Roi, Dillberry Lake 52°35'N 110°01'W, 2087; Altario 51°49'N 110°11'W, 1516; Hand Hills 51°23'N 112°12'W, 560; Wainwright 52°45'N 110°49'W, 1410;

Edgerton 52°45'N 110°28'W, 305; Provost 52°11'N 110°26'W, 825; Clandonald 53°35'N 110°45'W, 736; Battle R. x HW 36 52°25'N 111°49'W, 1020.

Spirea lucida Dougl., Cypress Hills (Breitung 1954).

LEGUMINOSAE

Astragalus aboriginum Richards., (Moss 1959; de Vries 1968).

Astragalus agrestis Dougl., Writing-on-Stone 49°07'N 111°39'W, 1102; Vermilion 53°22'N 110°53'W, 74; Hand Hills 51°23'N 112°12'W, 1258; Halkirk 52°23'N 112°00'W, 477; Seven Persons 49°52'N 110°53'W, 1176; Stettler 52°20'N 112°55'W, 35; Kinsella 53°03'N 111°32'W, 1282; Schuler 50°22'N 110°18'W, 649; Dinosaur 50°45'N 111°34'W, 1209; Neutral Hills 52°10'N 110°51'W, 464; Cypress Hills (de Vries and Bird 1968).

Astragalus bisulcatus (Hook.) A. Gray, Writing-on-Stone 49°07'N 111°39'W, 1709; Stettler 52°20'N 112°55'W, 33; Dinosaur 50°45'N 111°34'W, 1208; Seven Persons 49°52'N 110°53'W, 608; Empress 50°57'N 110°01'W, 1522; Edgerton 52°45'N 110°28'W, 112; Halkirk 52°23'N 112°00'W, 497.

Astragalus caespitosus (Nutt.) A. Gray, Onefour 49°06'N 110°36'W, 1141, 1623;

Astragalus canadensis L., Horseshoe Lake 52°21'N 110°44'W, 553; Dillberry Lake 52°35'N 110°01'W, 1420; Cypress Hills (Breitung 1954).

Astragalus crassicarpus Nutt., Writing-on-Stone 49°07'N 111°39'W, 1692; Nose Hills 52°10'N 111°10'W, 554; Hand Hills 51°23'N 112°12'W, 1244.

Astragalus drummondii Dougl., Pendant d'Oreille 49°12'N 110°53'W, 2358; Kinsella 53°03'N 111°32'W, 1849; HW 41 x Battle River 53°00'N 110°52'W, 401; Writing-on-Stone 49°07'N 111°39'W, 1100; Vermilion 53°22'N 110°53'W, 88; Lea Park 53°39'N 110°22'W, 853; Stettler 52°20'N 112°55'W, 31; Halkirk 52°23'N 112°00'W, 480.

Astragalus eucosmus Robins.,

Astragalus flexuosus Dougl., Kinsella 53°03'N 111°32'W, 1864; Isley 53°18'N 110°33'W, 513, 1821; HW 41 x Battle River 53°00'N 110°52'W, 400; Horseshoe Lake 52°21'N 110°44'W, 551.

Astragalus frigidus (L.) A. Gray var. *americanus* (Hook.) Wats. Laurier Lake 53°50'N 110°34'W, 2046.

Astragalus kentrophyta A. Gray, (Moss 1959; de Vries 1968).

Astragalus lotiflorus Hook., (Moss 1959).

Astragalus missouriensis Nutt., Dinosaur 50°45'N 111°34'W, 1203; Wainwright 52°45'N 110°49'W, 1372; Writing-on-Stone 49°07'N 111°39'W, 1052; Onefour 49°06'N 110°36'W, 1165.

Astragalus pectinatus (Hook.) Dougl., Altario 51°49'N 110°11'W, 2112; Dinosaur 50°45'N 111°34'W, 1205; Horseshoe Lake 52°21'N 110°44'W, 809; Onefour 49°06'N 110°36'W, 1144; Seven Persons 49°52'N 110°53'W, 609, 1181; Chin Coulee 49°34'N 111°52'W, 1027.

Astragalus purshii Dougl., (Moss 1954; de Vries 1968).

Astragalus striatus Nutt., Horseshoe Lake 52°21'N 110°44'W, 452; Onefour 49°06'N 110°36'W, 2236; Grant Creek 49°28'N 110°05'W, 1611; Horseshoe Lake 52°21'N 110°44'W, 551; Dinosaur 50°45'N 111°34'W, 1207; Writing-on-Stone 49°07'N 111°39'W, 1666.

Astragalus tenellus Pursh, Wildhorse 49°01'N 110°15'W, 2267; Pinhorn grazing res. 49°05'N 110°55'W, 2383; Dinosaur 50°45'N 111°34'W, 1217; Empress 50°57'N 110°01'W, 679; Wainwright 52°45'N 110°49'W, 99; Seven Persons 49°52'N 110°53'W, 613; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968); Cypress Hills (Breitung 1954).

Astragalus triphyllus Pursh, Seven Persons 49°52'N 110°53'W, 2203; Writing-on-Stone 49°07'N 111°39'W, 1064; Provost 52°11'N 110°26'W, 345; Onefour 49°06'N 110°36'W, 1153; Cypress Hills (de Vries 1968).

Astragalus vexilliflexus Sheld., (Moss 1959).

Glycyrrhiza lepidota (Nutt.) Pursh, Orion 49°25'N 110°50'W, 2335; Altario 51°49'N 110°11'W, 1490; Chappice Lake 50°09'N 110°21'W, 639; Onefour 49°06'N 110°36'W, 1631; Dillberry Lake 52°35'N 110°01'W, 313; Walsh 50°07'N 110°04'W, 1539; Seven Persons 49°52'N 110°53'W, 611; Writing-on-Stone 49°07'N 111°39'W, 1685.

Hedysarum alpinum L., Isley 53°18'N 110°33'W, 515; Kinsella 53°03'N 111°32'W, 1324; Birch Lake 53°19'N 111°29'W, 836; Hand Hills 51°23'N 112°12'W, 576.

Hedysarum boreale Nutt., Writing-on-Stone 49°07'N 111°39'W, 1668; Stettler 52°20'N 112°55'W, 62; Neutral Hills 52°10'N 110°51'W, 455; Cypress Hills (Breitung 1954).

Lathyrus ochroleucus Hook., Kinsella 53°03'N 111°32'W, 1275; Stettler 52°20'N 112°55'W, 72; Hand Hills 51°23'N 112°12'W, 1243; Horseshoe Lake 52°21'N 110°44'W, 412; HW 41 x Battle River 53°00'N 110°52'W, 85; Wainwright 52°45'N 110°49'W, 101; Cypress Hills (de Vries and Bird 1968).

Lathyrus venosus Muhl. var. *intonsus* Butters & St. John, Kinsella 53°03'N 111°32'W, 1310, 1873; Wainwright 52°45'N 110°49'W, 1360; Dillberry Lake 52°35'N 110°01'W, 1435; Isley 53°18'N 110°33'W, 511.

Lupinus argenteus Pursh, Writing-on-Stone 49°07'N 111°39'W, 1665; Cypress Hills (Breitung 1954).

Lupinus pusillus Pursh, (Moss 1959).

Lupinus sericeus Pursh, (Moss 1959).

Oxytropis campestris (L.) DC. var. *gracilis* (A. Nels.) Barneby, HW 41 x Battle River 53°00'N 110°52'W, 1400; Halkirk 52°23'N 112°00'W, 505; Hand Hills 51°23'N 112°12'W, 1782; Kinsella 53°03'N 111°32'W, 1872; Isley 53°18'N 110°33'W, 1827; Cypress Hills (Breitung 1954).

Oxytropis deflexa (Pall.) DC., Laurier Lake 53°50'N 110°34'W, 1393, 2029.

Oxytropis sericea Nutt. var. *spicata* (Hook.) Barneby, Empress 50°57'N 110°01'W, 1532; Horseshoe Lake 52°21'N 110°44'W, 439; Writing-on-Stone 49°07'N 111°39'W, 1090;

Stettler 52°20'N 112°55'W, 38; Onefour 49°06'N 110°36'W, 1145; Provost 52°11'N 110°26'W, 429; Cypress Hills (de Vries and Bird 1968).

Oxytropis splendens Dougl., Pinhorn grazing res. 49°05'N 110°55'W, 2382.

Petalostemon candidum (Willd.) Michx., Wildhorse 49°01'N 110°15'W, 2267; Dinosaur 50°45'N 111°34'W, 1734; Provost 52°11'N 110°26'W, 353; Writing-on-Stone 49°07'N 111°39'W, 1716.

Petalostemon purpureum (Vent.) Rydb., Chappice Lake 50°09'N 110°21'W, 635; Big Knife 52°29'N 112°11'W, 1934; Provost 52°11'N 110°26'W, 354; Onefour 49°06'N 110°36'W, 1616; Dinosaur 50°45'N 111°34'W, 1744; Aden 49°04'N 111°17'W, 1649.

Psoralea argophylla Pursh, Kinsella 53°03'N 111°32'W, 1309; Walsh 50°07'N 110°04'W, 631; Big Knife 52°29'N 112°11'W, 1936; HW 41 x Battle River 53°00'N 110°52'W, 250; Empress 50°57'N 110°01'W, 1524.

Psoralea esculenta Pursh, Lea Park 53°39'N 110°22'W, 850; Empress 50°57'N 110°01'W, 1531; Provost 52°11'N 110°26'W, 349.

Psoralea lanceolata Pursh, Onefour 49°06'N 110°36'W, 2238; Walsh 50°07'N 110°04'W, 1546; Chappice Lake 50°09'N 110°21'W, 634.

Thermopsis rhombifolia (Nutt.) Richards, Onefour 49°06'N 110°36'W, 1130; Stettler 52°20'N 112°55'W, 41; Horseshoe Lake 52°21'N 110°44'W, 416, 785; Kinsella 53°03'N 111°32'W, 1013; Chin Coulee 49°34'N 111°52'W, 1034.

Vicia americana Muhl., Dillberry Lake 52°35'N 110°01'W, 2059; Hand Hills 51°23'N 112°12'W, 1761; Writing-on-Stone 49°07'N 111°39'W, 1079; Stettler 52°20'N 112°55'W, 42; Horseshoe Lake 52°21'N 110°44'W, 414; Cypress Hills (de Vries and Bird 1968).

Vicia sparsifolia Nutt., Stettler 52°20'N 112°55'W, 39; Hand Hills 51°23'N 112°12'W, 1263; Isley 53°18'N 110°33'W, 514; Writing-on-Stone 49°07'N 111°39'W, 1691; Dinosaur 50°45'N 111°34'W, 1201; Kinsella 53°03'N 111°32'W, 1281; Seven Persons 49°52'N 110°53'W, 1175.

Geranium bricknelli Britt., Cypress Hills (U. of A. distr. map).

Geranium richardsonii Fisch. & Trautv. Cypress Hills (Breitung 1954).

Geranium viscosissimum Fisch. & Mey., Writing-on-Stone 49°07'N 111°39'W, 1664; 1.5 km north of Elkwater, 1346, 1574; Cypress Hills (Breitung 1954).

LINACEAE

Linum lewisii Pursh, Altario 51°49'N 110°11'W, 2169; Grant Creek 49°28'N 110°05'W, 1598; Seven Persons 49°52'N 110°53'W, 582; HW 41 x Battle River 53°00'N 110°52'W, 1346; Writing-on-Stone 49°07'N 111°39'W, (de Vries

1968).

Linum rigidum Pursh, Altario 51°49'N 110°11'W, 2173; Writing-on-Stone 49°07'N 111°39'W, 1687; Pendant d'Oreille 49°12'N 110°53'W, 2354; Cypress Hills (Breitung 1954).

EUPHORBIACEAE

Euphorbia glyptosperma Engelm., Conrad 49°31'N 112°00'W, 2298.

Euphorbia serpyllifolia Pers., Horseshoe Lake 52°21'N 110°44'W, 822.

POLYGALACEAE

Polygala senega L., Wainwright 52°45'N 110°49'W, 1401; Laurier Lake 53°50'N 110°34'W, 1379; HW 41 x Battle River 53°00'N 110°52'W, 8.

CALLITRICHACEAE

Callitriche hermaphroditica L., (Moss 1959).

Callitriche palustris L., U. of A. distr. map).

ANACARDACEAE

Rhus radicans L. var. rydbergii (Small) Rehder Dillberry Lake 52°35'N 110°01'W, 1452; Horseshoe Lake 52°21'N 110°44'W, 417; Wainwright 52°45'N 110°49'W, 1409; Empress 50°57'N 110°01'W, 680; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968).

Rhus trilobata Nutt., Onefour 49°06'N 110°36'W, 1624; Pendant d'Oreille 49°12'N 110°53'W, 2361; Writing-on-Stone 49°07'N 111°39'W, 1095; Empress 50°57'N 110°01'W, 675; Dinosaur 50°45'N 111°34'W, 1215.

MALVACEAE

Sphaeralcea coccinea (Pursh) Rydb., Onefour 49°06'N 110°36'W, 1634; Wildhorse 49°01'N 110°15'W, 2277; Walsh 50°07'N 110°04'W, 1563; Nose Hills 52°10'N 111°10'W, 555; Kinsella 53°03'N 111°32'W, 1307; Provost 52°11'N 110°26'W, 348; Writing-on-Stone 49°07'N 111°39'W, 1669; Dinosaur 50°45'N 111°34'W, 1220.

ELATINACEAE

Elatine triandra Schk., (Moss 1959).

VIOLACEAE

Viola adunca J.E. Smith, Hand Hills 51°23'N 112°12'W, 1245; Writing-on-Stone 49°07'N 111°39'W, 1098; Edgerton

52°45'N 110°28'W, 106; Kinsella 53°03'N 111°32'W, 1001; Cypress Hills (de Vries and Bird 1968).

Viola nephrophila Greene, Kinsella 53°03'N 111°32'W, 1293; Edgerton 52°45'N 110°28'W, 123; Cypress Hills (de Vries and Bird).

Viola nuttallii Pursh, Onefour 49°06'N 110°36'W, 1152; Chin Coulee 49°34'N 111°52'W, 1043; Cypress Hills (de Vries and Bird 1968).

Viola palustris L., Horseshoe Lake 52°21'N 110°44'W, 778.

Viola pedatifida G. Don, (Moss 1959).

Viola renifolia A. Gray, Cypress Hills (de Vries and Bird 1968).

Viola rugulosa Greene, Dillberry Lake 52°35'N 110°01'W, 2048; Kinsella 53°03'N 111°32'W, 1874; Halkirk 52°23'N 112°00'W, 485; Wainwright 52°45'N 110°49'W, 1361; Vermilion 53°22'N 110°53'W, 982; Hand Hills 51°23'N 112°12'W, 1239; Lea Park 53°39'N 110°22'W, 162; HW 41 x Battle River 53°00'N 110°52'W, 1342; Cypress Hills (Breitung 1954).

LOASACEAE

Mentzelia decapetala (Pursh) Urban & Gilg, Writing-on-Stone 49°07'N 111°39'W, 1715.

CACTACEAE

Mamillaria vivipara (Nutt.) Haw., Chin Coulee 49°34'N 111°52'W, 1040; Dinosaur 50°45'N 111°34'W, 1735; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968).

Opuntia fragilis (Nutt.) Haw., (Moss 1959).

Opuntia polyacantha Haw., Onefour 49°06'N 110°36'W, 2279; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968).

ELEAGNACEAE

Eleagnus commutata Bernh., Altario 51°49'N 110°11'W, 2126; Onefour 49°06'N 110°36'W, 2242; Writing-on-Stone 49°07'N 111°39'W, 1128; Hand Hills 51°23'N 112°12'W, 561; Wainwright 52°45'N 110°49'W, 98; Horseshoe Lake 52°21'N 110°44'W, 442; Cypress Hills (de Vries and Bird 1968).

Shepherdia argentea Nutt., Pendant d'Oreille 49°12'N 110°53'W, 2364; Dinosaur 50°45'N 111°34'W, 1743; Empress 50°57'N 110°01'W, 699; Writing-on-Stone 49°07'N 111°39'W, 1073.

Shepherdia canadensis (L.) Nutt., Big Knife 52°29'N 112°11'W, 1948; Kinsella 53°03'N 111°32'W, 1325; Hand Hills 51°23'N 112°12'W, 1241; Horseshoe Lake 52°21'N 110°44'W, 797; Provost 52°11'N 110°26'W, 329; Clandonald 53°35'N 110°45'W, 739; Cypress Hills (de Vries and Bird 1968).

ONAGRACEAE

Boisduvalia glabella (Nutt.) Walp., (Moss 1959).
Circaea alpina L., (Moss 1959).
Epilobium alpinum L., Cypress Hills (de Vries and Bird 1968).
Epilobium angustifolium L., Dillberry Lake 52°35'N 110°01'W, 2108; Common throughout the parkland.
Epilobium glandulosum Lehm., Seven Persons 49°52'N 110°53'W, 2214; Conrad 49°31'N 112°00'W, 2304; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968).
Epilobium paniculatum Nutt., Onefour 49°06'N 110°36'W, 2279; Seven Persons 49°52'N 110°53'W, 2199; Wildhorse 49°01'N 110°15'W, 2273; Orion 49°25'N 110°50'W, 2343.
Gaura coccinea Pursh, Onefour 49°06'N 110°36'W, 2244; Altario 51°49'N 110°11'W, 2164; Wildhorse 49°01'N 110°15'W, 2275; Provost 52°11'N 110°26'W, 337; Dinosaur 50°45'N 111°34'W, 1222; Horseshoe Lake 52°21'N 110°44'W; 550; Aden 49°04'N 111°17'W, 1654; Edgerton 52°45'N 110°28'W, 113; Wainwright 52°45'N 110°49'W, 1371; Writing-on-Stone 49°07'N 111°39'W, 1062; Kinsella 53°03'N 111°32'W, 1303.
Oenothera andina Nutt, (Moss 1959).
Oenothera biennis L., Orion 49°25'N 110°50'W, 2346; Monitor, 2417; Pendant d'Oreille 49°12'N 110°53'W, 2363; Dillberry Lake 52°35'N 110°01'W, 1456; Clandonald 53°35'N 110°45'W, 746; Cypress Hills (de Vries and Bird 1968).
Oenothera brevifolia (Nutt.) T. & G., (Moss 1959).
Oenothera caespitosa Nutt., Onefour 49°06'N 110°36'W, 1133; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968).
Oenothera flava (A. Nels.) Garrett, (Breitung 1954; Moss 1959).
Oenothera nuttallii Sweet, Dillberry Lake 52°35'N 110°01'W, 319; Dinosaur 50°45'N 111°34'W, 1754; Horseshoe Lake 52°21'N 110°44'W, 807; Altario 51°49'N 110°11'W, 1489;
Oenothera serrulata Nutt., Onefour 49°06'N 110°36'W, 2283; Altario 51°49'N 110°11'W, 2174.

HIPPURIDACEAE

Hippuris vulgaris L., Hand Hills 51°23'N 112°12'W, 1768; Empress 50°57'N 110°01'W, 712; Tulliby Lake 53°45'N 110°11'W, 863; Cypress Hills (Breitung 1954).

HALOGARIDACEAE

Myriophyllum exalbescens Fern., Acadia Valley 51°15'N 110°13'W, 2148; Wainwright 52°45'N 110°49'W, 248; HW 41 x Battle River 53°00'N 110°52'W, 400; Vermilion 53°22'N 110°53'W, 399; Cypress Hills (Breitung 1954).
Myriophyllum verticillatum L., Cypress Hills (U. of A. distr. map).

ARALIACEAE

(Moss 1959).

Aralia nudicaulis L., Stettler 52°20'N 112°55'W, 69; Halkirk 52°23'N 112°00'W, 487; Wainwright 52°45'N 110°49'W, 124; Cypress Hills (Breitung 1954).

UMBELLIFERAE

Cicuta douglasii (DC.) Coult. & Rose, Dillberry Lake 52°35'N 110°01'W, 2077; Kinsella 53°03'N 111°32'W, 1351; Horseshoe Lake 52°21'N 110°44'W, 766. Writing-on-Stone 49°07'N 111°39'W, 1083, 1657.

Cymopterus acaulis (Pursh) Raf., Dinosaur 50°45'N 111°34'W, 1223; Writing-on-Stone 49°07'N 111°39'W, 1054.

Heracleum lanatum Michx., Hand Hills 51°23'N 112°12'W, 1256; Writing-on-Stone 49°07'N 111°39'W, 1084; Cypress Hills (de Vries and Bird).

Lomatium cous (Wats.) Coult. & Rose, Cypress Hills, Scott 1135.

Lomatium foeniculaceum (Nutt.) Coult. & Rose, Big Knife 52°29'N 112°11'W, 60; Seven Persons 49°52'N 110°53'W, 1178; Writing-on-Stone 49°07'N 111°39'W, 1087.

Lomatium macrocarpum (Hook. & Arn.) Coult. & Rose, Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968); Cypress Hills (Breitung 1954).

Lomatium simplex (Nutt) Macbr var *leptophyllum* (Hook) Mathias, (Moss 1959).

Lomatium triternatum (Pursh) Coult. & Rose, Onefour 49°06'N 110°36'W, 1129.

Musineon divaricatum (Pursh) Nitt. var. *hookeri* T. & G., Chin Coulee 49°34'N 111°52'W, 1044; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968); Dinosaur 50°45'N 111°34'W, 1197.

Osmorhiza depauperata Philippi, Hand Hills 51°23'N 112°12'W, 1248; Cypress Hills (de Vries and Bird 1968).

Osmorhiza longistylis (Torr.) DC., Medicine Hat, Moss 10795.

Osmorhiza purpurea (Coult. & Rose) Suksd., Cypress Hills (de Vries and Bird 1968).

Perideridia gairdneri (Hook. & Arn.) Mathias, Grant Creek 49°28'N 110°05'W, 1591; Cypress Hills (de Vries and Bird 1968).

Sanicula marilandica L., Hand Hills 51°23'N 112°12'W, 570; Laurier Lake 53°50'N 110°34'W, 1395; Cypress Hills (de Vries and Bird 1968).

Sium suave Walt., Dillberry Lake 52°35'N 110°01'W, 1486; Altario 51°49'N 110°11'W, 2140; Hand Hills 51°23'N 112°12'W, 1768; Oyen 51°23'N 110°28'W, 735.

Zizia aptera (A. Gray) Fern., Altario 51°49'N 110°11'W, 2136; Hand Hills 51°23'N 112°12'W, 1237; Halkirk 52°23'N 112°00'W, 469; Dillberry Lake 52°35'N 110°01'W, 1483; Edgerton 52°45'N 110°28'W, 120; Kinsella 53°03'N 111°32'W, 1290; Cypress Hills (Breitung 1954).

CORNACEAE

Cornus canadensis L., Isley 53°18'N 110°33'W, 512; Halkirk 52°23'N 112°00'W, 484; Cypress Hills (de Vries and Bird 1968).

Cornus stolonifera Michx., Dillberry Lake 52°35'N 110°01'W, 2051; Big Knife 52°29'N 112°11'W, 1944; Halkirk 52°23'N 112°00'W, 490; Writing-on-Stone 49°07'N 111°39'W, 1077; Lea Park 53°39'N 110°22'W, 166; Hand Hills 51°23'N 112°12'W, 1262; Cypress Hills (de Vries and Bird 1968).

PYROLACEAE

Chimaphila umbellata (L.) Bart. var. *occidentalis* (Rydb.) Blake,

Aster eatonii (A. Gray) Howell, Cypress Hills (Breitung 1954). Cypress Hills (Breitung 1954).

Monesis uniflora (L.) A. Gray, Laurier Lake 53°50'N 110°34'W, 2042; Elk Point 53°55'N 110°50'W, 359; Cypress Hills (de Vries and Bird 1968).

Pyrola asarifolia Michx., Wainwright 52°45'N 110°49'W, 1367; Horseshoe Lake 52°21'N 110°44'W, 542, 794; Dillberry Lake 52°35'N 110°01'W, 1426; Hand Hills 51°23'N 112°12'W, 571; Birch Lake 53°19'N 111°29'W, 202; Cypress Hills (de Vries and Bird 1968).

Pyrola elliptica Nutt., Lea Park 53°39'N 110°22'W, 844; Wainwright 52°45'N 110°49'W, 217; Provost 52°11'N 110°26'W, 824; HW 41 x Battle River 53°00'N 110°52'W, 252; Cypress Hills (de Vries and Bird 1968).

Pyrola minor L., Cypress Hills (Breitung 1954).

Pyrola secunda L., HW 41 x Battle River 53°00'N 110°52'W, 1397; Wainwright 52°45'N 110°49'W, 1362; Horseshoe Lake 52°21'N 110°44'W, 795; Birch Lake 53°19'N 111°29'W, 200; Cypress Hills (Breitung 1954).

Pyrola virens Schweigg., Birch Lake 53°19'N 111°29'W, 205.

Pterospora andromeda Nutt., Cypress Hills (Moss 1959).

ERICACEAE

Arctostaphylos uva-ursi (L.) Spreng., Big Knife 52°29'N 112°11'W, 1943; Hand Hills 51°23'N 112°12'W, 575, 1251; Horseshoe Lake 52°21'N 110°44'W, 418, 796; Cypress Hills (de Vries and Bird 1968).

Ledum groenlandicum Oeder., northeastern parkland (U. of A. distr. map).

Vaccinium caespitosum Michx., Cypress Hills (Breitung 1954).

PRIMULACEAE

Androsace occidentalis Pursh, Chin Coulee 49°34'N 111°52'W, 1037.

Androsace septentrionalis L., Seven Persons 49°52'N 110°53'W, 2211; Writing-on-Stone 49°07'N 111°39'W, 1702; Grant Creek 49°28'N 110°05'W, 1589; Lea Park 53°39'N 110°22'W, 8; Vermilion 53°22'N 110°53'W, 999.

Centunculus minimus L., (Moss 1959).

Dodecatheon conjugens Greene, Cypress Hills (Breitung 1954).

Dodecatheon radicatum Greene, Writing-on-Stone 49°07'N 111°39'W, 1069; Edgerton 52°45'N 110°28'W, 119; Hand Hills 51°23'N 112°12'W, 1779; Kinsella 53°03'N 111°32'W, 1286; Altario 51°49'N 110°11'W, 1502; Cypress Hills (Breitung 1954).

Glaux maritima L., Pinhorn grazing res. 49°05'N 110°55'W, 2392; Altario 51°49'N 110°11'W, 2130; Writing-on-Stone 49°07'N 111°39'W, 1109; Tulliby Lake 53°45'N 110°11'W, 867; HW 41 x Battle River 53°00'N 110°52'W, 1339.

Lysimachia ciliata L., Wainwright 52°45'N 110°49'W, 214; Dillberry Lake 52°35'N 110°01'W, 2057; Big Knife 52°29'N 112°11'W, 1909; Cypress Hills (de Vries and Bird 1968).

Lysimachia hybrida Michx., Two Hills 53°40'N 111°05'W, 934; Oyen 51°23'N 110°28'W, 729.

Lysimachia thyrsiflora L., Wainwright 52°45'N 110°49'W, 1359.

Primula incana M.E. Jones., Kinsella 53°03'N 111°32'W, 1287, 1354; Cypress Hills (de Vries and Bird 1968).

GENTIANACEAE

Gentiana affinis Griseb., Onefour 49°06'N 110°36'W, 2282; Cypress Hills (Breitung 1954).

Gentianella amarella (L.) Borner ssp. *acuta* (Michx.) J.M. Gillett, Altario 51°49'N 110°11'W, 1493; Lea Park 53°39'N 110°22'W, 839; Horseshoe Lake 52°21'N 110°44'W, 799; Birch Lake 53°19'N 111°29'W, 828; Cypress Hills (Breitung 1954).

Gentianella crinata (Froel.) G.Don *macounii* (Holm) J.M. Gillett, Two Hills 53°40'N 111°05'W, 963; Tulliby Lake 53°45'N 110°11'W, 860.

APOCYNACEAE

Apocynum androsaemifolium L., Lea Park 53°39'N 110°22'W, 838; Writing-on-Stone 49°07'N 111°39'W, 1684; Wainwright 52°45'N 110°49'W, 1369; Big Knife 52°29'N 112°11'W, 1940; Cypress Hills (Breitung 1954).

Apocynum sibiricum Jacq., Empress 50°57'N 110°01'W, 721; Grant Creek 49°28'N 110°05'W, 1608.

ASCLEPIADACEAE

Asclepias ovalifolia Dene., Dillberry Lake 52°35'N 110°01'W, 1417; Two Hills 53°40'N 111°05'W 1348; Wainwright 52°45'N 110°49'W, 1374.

Asclepias speciosa Torr., Seven Persons 49°52'N 110°53'W, 610; Walsh 50°07'N 110°04'W, 1538; Writing-on-Stone

49°07'N 111°39'W, 1656, 2350.

Asclepias viridiflora Raf., Writing-on-Stone 49°07'N 111°39'W.

POLEMONIACEAE

Collomia linearis Nutt., Wildhorse 49°01'N 110°15'W, 2227; Seven Persons 49°52'N 110°53'W, 2221; Onefour 49°06'N 110°36'W, 2281; Dillberry Lake 52°35'N 110°01'W, 2080; Conrad 49°31'N 112°00'W, 2292; Halkirk 52°23'N 112°00'W, 479; Empress 50°57'N 110°01'W, 1526; HW 41 x Battle River 53°00'N 110°52'W, 1345; Writing-on-Stone 49°07'N 111°39'W; Cypress Hills (Breitung 1954).

Linanthus septentrionalis H.L. Mason, (Moss 1959).

Navarretia minima Nutt., Onefour 49°06'N 110°36'W, 2280; Wildhorse 49°01'N 110°15'W, 2253.

Phlox hoodii Richards., Onefour 49°06'N 110°36'W, 1160; Hand Hills 51°23'N 112°12'W, 1379; Edgerton 52°45'N 110°28'W, 114; Wainwright 52°45'N 110°49'W, 124; Cypress Hills (Breitung 1954).

HYDROPHYLLACEAE

Ellisia nyctela L., (Moss 1959).

BORAGINACEAE

Cryptandra bradburiana Payson, Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968), Cypress Hills (de Vries and Bird 1968).

Cryptandra fendleri (A. Gray) Greene, Orion 49°25'N 110°50'W, 2327; Onefour 49°06'N 110°36'W, 2251.

Cryptantha macounii (Eastw.) Payson, Onefour 49°06'N 110°36'W, 1132.

Hackelia americana (A. Gray) Fern., Dillberry Lake 52°35'N 110°01'W, 2106; Empress 50°57'N 110°01'W, 682; Cypress Hills (Breitung 1954).

Hackelia floribunda (Lehm.) I. M. Johnston, Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968).

Hackelia jessicae (McGreg.) Brand, (U. of A. distr. map).

Heliotropium curassavicum L. var. *obovatum* DC., (Moss 1959).

Lappula redowskii (Hornem.) Greene var. *occidentalis* (Wats) Rydb., Pinhorn grazing res. 49°05'N 110°55'W, 2390; Writing-on-Stone 49°07'N 111°39'W, 1099; Horseshoe Lake 52°21'N 110°44'W, 443.

Lithospermum incisum Lehm., Orion 49°25'N 110°50'W, 2313; Writing-on-Stone 49°07'N 111°39'W, 1114.

Lithospermum ruderale Lehm., Cypress Hills (Breitung 1954); Writing-on-Stone 49°07'N 111°39'W, (U. of A. distr. map).

Mertensia paniculata (Ait.) G. Don, northern fringe of the parkland (U. of A. distr. map).

Plagiobothrys scopulorum (Greene) I. M. Johnston Conrad

49°31'N 112°00'W, 2307; Cypress Hills (Breitung 1954).

VERBENACEAE

Verbena bracteata Lag. & Rodr., Conrad 49°31'N 112°00'W, 2302; S. Sask. Riv. x HW 41 50°44'N 110°05'W, 2402.

LABIATAE

Agastache foeniculum (Pursh) Ktze., Big Knife 52°29'N 112°11'W, 1946; Lea Park 53°39'N 110°22'W, 849; Clandonald 53°35'N 110°45'W, 740; HW 41 x Battle River 53°00'N 110°52'W, 239.

Dracocephalum nuttallii Britt., Lea Park 53°39'N 110°22'W, 847; HW 41 x Battle River 53°00'N 110°52'W, 241; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968); Cypress Hills (de Vries and Bird 1968).

Hedeoma hispida Pursh, (Moss 1959).

Lycopus americanus Muhl., Wainwright 52°45'N 110°49'W, 221.

Lycopus asper Greene., Dillberry Lake 52°35'N 110°01'W, 318, 2072; Horseshoe Lake 52°21'N 110°44'W, 768;

Mentha arvensis L.var. *villosa* (Benth.) S.R. Stewart, Wildhorse 49°01'N 110°15'W, 2264; Seven Persons 49°52'N 110°53'W, 2224; Dillberry Lake 52°35'N 110°01'W, 1471; Oyen 51°23'N 110°28'W, 728; Hand Hills 51°23'N 112°12'W, 1773; Writing-on-Stone 49°07'N 111°39'W, 1658; Big Knife 52°29'N 112°11'W, 1919.

Moldavica parviflora (Nutt.) Britt., Cypress Hills (de Vries and Bird 1968).

Monarda fistulosa L.var. *menthaefolia* (Graham) Fern., Aden 49°04'N 111°17'W, 1645; Kinsella 53°03'N 111°32'W, 1861; Seven Persons 49°52'N 110°53'W, 612; Big Knife 52°29'N 112°11'W, 1925; Wainwright 52°45'N 110°49'W, 228; Clandonald 53°35'N 110°45'W, 741.

Scutellaria galericulata L., Dillberry Lake 52°35'N 110°01'W, 1415, 1475.

Stachys palustris L.var. *pilosa* (Nutt.) Fern., Wildhorse 49°01'N 110°15'W, 2263; Acadia Valley 51°15'N 110°13'W, 2161; Hand Hills 51°23'N 112°12'W, 1771; Birch Lake 53°19'N 111°29'W, 829; Walsh 50°07'N 110°04'W, 1571; Seven Persons 49°52'N 110°53'W, 605; Big Knife 52°29'N 112°11'W, 1910; Clandonald 53°35'N 110°45'W, 737.

SOLANACEAE

Solanum triflorum Nutt., Altario 51°49'N 110°11'W, 2118.

SCROPHULARIACEAE

Besseya cinerea (Raf.) Pennell, Cypress Hills (Breitung 1954).

Castilleja miniata Dougl., Wainwright 52°45'N 110°49'W, 1364; Tulliby Lake 53°45'N 110°11'W, 861; Hand Hills

51°23'N 112°12'W, 568; Cypress Hills (Breitung 1954).

Castilleja septentrionalis Lindl., Hand Hills 51°23'N 112°12'W, 561.

Castilleja sessiliflora Pursh, Onefour 49°06'N 110°36'W, (Smoliak and Johnston 1978).

Collinsia parviflora Dougl., Cypress Hills (de Vries and Bird 1968).

Gratiola neglecta Torr., (U. of A. distr. map)

Limosella aquatica L., Redcliff 50°05'N 110°47'W, Moss 10446.

Mimulus guttatus DC., Cypress Hills (Breitung 1954).

Orthocarpus luteus Nutt., Pinhorn grazing res. 49°05'N 110°55'W, 2376; Onefour 49°06'N 110°36'W, 2252; Kinsella 53°03'N 111°32'W, 1860; Provost 52°11'N 110°26'W, 352; Isley 53°18'N 110°33'W, 1824; Schuler 50°22'N 110°18'W, 654; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968).

Pedicularis bracteosa Benth., Cypress Hills, Cormack 562.

Pedicularis groenlandica Retz., Horseshoe Lake 52°21'N 110°44'W, 781.

Penstemon albidus Nutt., Onefour 49°06'N 110°36'W, 1161; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968).

Penstemon confertus Dougl., Onefour 49°06'N 110°36'W, Boivin 9544.

Penstemon gracilis Nutt., Kinsella 53°03'N 111°32'W, 1866; Writing-on-Stone 49°07'N 111°39'W, 1117.

Penstemon nitidus Dougl., Seven Persons 49°52'N 110°53'W, 589; Hand Hills 51°23'N 112°12'W, 1255; Onefour 49°06'N 110°36'W, 1140; Writing-on-Stone 49°07'N 111°39'W, de Vries 1968.

Penstemon procerus Dougl., Vermilion 53°22'N 110°53'W, 77; Big Knife 52°29'N 112°11'W, 1892; Kinsella 53°03'N 111°32'W, 1311; Hand Hills 51°23'N 112°12'W, 1264; Cypress Hills (Breitung 1954).

Rhinanthus crista-galli L., Cypress Hills (Breitung 1954).

Veronica americana (Raf.) Schw., Lea Park 53°39'N 110°22'W, 842; Wainwright 52°45'N 110°49'W, 1363; Cypress Hills (Breitung 1954).

Veronica peregrina L.var. *xalapensis* (HBK) St John & Warren, Conrad 49°31'N 112°00'W, 2306; Wildhorse 49°01'N 110°15'W, 2254.,

Veronica salina Schur (Moss 1959).

Veronica scutellata L. Craigmyle 51°40'N 112°20'W Brinkman, 5427.

Veronica serpyllifolia L. var. *humifusa* (Dickson) Vahl Cypress Hills (de Vries and Bird 1968).

OROBANCHACEAE

Orobanche fasciculata Nutt., Hand Hills 51°23'N 112°12'W, 577; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968); Cypress Hills (Breitung 1954).

Orobanche ludoviciana Nutt., (Moss 1959; de Vries 1968).

LENTIBULARIACEAE

Utricularia intermedia Hayne, Cypress Hills (U. of A. distr. map).
Utricularia minor L., Cypress Hills (Breitung 1954).
Utricularia vulgaris L. var. *americana* A. Gray, Dillberry Lake 52°35'N 110°01'W, 1465; Provost 52°11'N 110°26'W, 827; Cypress Hills (Breitung 1954).

PLANTAGINACEAE

Plantago elongata Pursh, (Moss 1959).
Plantago eriopoda Torr., Pinhorn grazing res. 49°05'N 110°55'W, 2380.
Plantago purshii R. & S., Aden 49°04'N 111°17'W, 1647; Seven Persons 49°52'N 110°53'W, 632, 2201; Dinosaur 50°45'N 111°34'W, 1192, 1740; Onefour 49°06'N 110°36'W, 1157; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968).
Plantago spinulosa Dene., Seven Persons 49°52'N 110°53'W, 628, 2202.

RUBIACEAE

Galium aparine L., (Moss 1959).
Galium boreale L., Horseshoe Lake 52°21'N 110°44'W, 792; Wainwright 52°45'N 110°49'W, 218; Edgerton 52°45'N 110°28'W; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968); Cypress Hills (de Vries and Bird 1968).
Galium trifidum L., Wainwright 52°45'N 110°49'W, 1357.
Galium triflorum Michx., Cypress Hills (Breitung 1954).
Houstonia longifolia Gaertn., Laurier Lake 53°50'N 110°34'W, 2033; Wainwright 52°45'N 110°49'W, 1365.

CAPRIFOLIACEAE

Linnaea borealis L. var. *americana* (Forbes) Rehd. Dillberry Lake 52°35'N 110°01'W, 310; Wainwright 52°45'N 110°49'W, 222, 1368; Cypress Hills (de Vries and Bird 1968).
Lonicera dioica L. var. *glaucescens* (Rydb.) Butters, HW 41 x Battle River 53°00'N 110°52'W, 83; Horseshoe Lake 52°21'N 110°44'W, 410; Wainwright 52°45'N 110°49'W, 93.
Symphoricarpos albus (L.) Blake, Wainwright 52°45'N 110°49'W, 95; Edgerton 52°45'N 110°28'W, 308; Cypress Hills (de Vries and Bird 1968).
Symphoricarpos occidentalis Hook., Dillberry Lake 52°35'N 110°01'W, 2053; Altario 51°49'N 110°11'W, 2125; Birch Lake 53°19'N 111°29'W, 209; Cypress Hills (de Vries and Bird 1968).
Viburnum edule (Michx.) Raf., Hand Hills 51°23'N 112°12'W, 573; Lea Park 53°39'N 110°22'W, 170; Cypress Hills (de Vries and Bird 1968).
Campanula rotundifolia L., Altario 51°49'N 110°11'W, 2115;

Pinhorn grazing res. 49°05'N 110°55'W, 2374; Birch Lake 53°19'N 111°29'W, 210; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968); Cypress Hills (de Vries and Bird 1968).

LOBELIACEAE

Downingia laeta Greene, Walsh 50°07'N 110°04'W, (Smoliak and Johnston 1978).

Lobelia kalmii L., Horseshoe Lake 52°21'N 110°44'W, 772.

COMPOSITAE

Achillea millefolium L. ssp. *lanulosa* (Nutt.) Piper, Altario 51°49'N 110°11'W, 2119; Orion 49°25'N 110°50'W, 2334; Dillberry Lake 52°35'N 110°01'W, 1432; Chin Coulee 49°34'N 111°52'W, 1029; Horseshoe Lake 52°21'N 110°44'W, 757; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968); Cypress Hills (Breitung 1954).

Achillea sibirica Ledeb., Dillberry Lake 52°35'N 110°01'W, 327.

Agoseris glauca (pursh) Raf., Wildhorse 49°01'N 110°15'W, 2266; Seven Persons 49°52'N 110°53'W, 2215; Pinhorn grazing res. 49°05'N 110°55'W, 2373; Onefour 49°06'N 110°36'W, 1155; Halkirk 52°23'N 112°00'W, 473; Big Knife 52°29'N 112°11'W, 1911; Writing-on-Stone 49°07'N 111°39'W, 1700; Kinsella 53°03'N 111°32'W, 1865; Altario 51°49'N 110°11'W, 1506; Dillberry Lake 52°35'N 110°01'W; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968); Cypress Hills (Breitung 1954).

Ambrosia artemisiifolia L. var. *elatior* (L.) Descourtils, (Moss 1959).

Ambrosia psilostachya DC. var. *coronopifolia* (T.&G.) Farw., (Moss 1959).

Ambrosia trifida L., (Moss 1959).

Anaphalis margaritacea (L.) Benth. & Hook., Cypress Hills (Breitung 1954).

Antennaria corymbosa E. Nels., Cypress Hills (Breitung 1954).

Antennaria dimorpha (Nutt.) T.& G., Chin Coulee 49°34'N 111°52'W, 1047; Writing-on-Stone 49°07'N 111°39'W, 1121.

Antennaria neglecta Greene, Cypress Hills (Breitung 1954).

Antennaria nitida Greene, Pinhorn grazing res. 49°05'N 110°55'W, 2389; Altario 51°49'N 110°11'W, 1492; Horseshoe Lake 52°21'N 110°44'W, 756; Onefour 49°06'N 110°36'W, 1163; Stettler 52°20'N 112°55'W, 65; Writing-on-Stone 49°07'N 111°39'W, 1103; Provost 52°11'N 110°26'W, 435; Halkirk 52°23'N 112°00'W, 476; Edgerton 52°45'N 110°28'W, 406; Cypress Hills (Breitung 1954).

Antennaria parviflora Nutt., Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968); Cypress Hills (de Vries and Bird 1968).

Antennaria pulcherrima (Hook.) Greene, Hand Hills 51°23'N 112°12'W, 1780; Cypress Hills (Breitung 1954).

Antennaria rosea Greene, Stettler 52°20'N 112°55'W, 66; Cypress Hills (Breitung 1954).

Antennaria umbrinella Rydb., Cypress Hills (U. of A. distr. map).

Arnica chamissonis Less., (Moss 1959; Breitung 1954).

Arnica cordifolia Hook., Cypress Hills (de Vries and Bird 1968).

Arnica fulgens Pursh, (Moss 1959).

Arnica sororia Greene, Dinosaur 50°45'N 111°34'W, 1210; Halkirk 52°23'N 112°00'W, 472; Seven Persons 49°52'N 110°53'W, 1174.

Artemesia biennis Willd., Conrad 49°31'N 112°00'W, 2303; Monitor, 2415; Pendant d'Oreille 49°12'N 110°53'W, 2369; Wainwright 52°45'N 110°49'W, 332.

Artemisia campestris L., Orion 49°25'N 110°50'W, 2340; Dillberry Lake 52°35'N 110°01'W, 2085; Altario 51°49'N 110°11'W, 2175; Horseshoe Lake 52°21'N 110°44'W, 760; Lea Park 53°39'N 110°22'W, 11; Provost 52°11'N 110°26'W, 336; Chappice Lake 50°09'N 110°21'W, 636; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968); Cypress Hills (de Vries and Bird 1968).

Artemesia cana Pursh, Dinosaur 50°45'N 111°34'W, 1212; Halkirk 52°23'N 112°00'W, 496; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968); Cypress Hills (Breitung 1954).

Artemisia dranunculus L., (U. of A. distr. map; Moss 1959).

Artemesia frigida Willd., Altario 51°49'N 110°11'W, 2120; Horseshoe Lake 52°21'N 110°44'W, 764; Dillberry Lake 52°35'N 110°01'W, 2101; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968).

Artemesia longifolia Nutt., Seven Persons 49°52'N 110°53'W, 2208; Big Knife 52°29'N 112°11'W, 1936; Stettler 52°20'N 112°55'W, 73; Dinosaur 50°45'N 111°34'W, 1214.

Artemesia ludoviciana Nutt., Dillberry Lake 52°35'N 110°01'W, 312, Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968).

Artemsia dranunculus L., (Moss 1959).

Aster adscendens Lindl., Cypress Hills (Breitung 1954).

Aster brachyactis Blake, (Moss 1959).

Aster canescens Pursh, Wildhorse 49°01'N 110°15'W, 2278; Grant Creek 49°28'N 110°05'W, 1581.

Aster ciliolatus Lindl., Two Hills 53°40'N 111°05'W, 253; Cypress Hills (Breitung 1954).

Aster conspicuus Lindl., Lea Park 53°39'N 110°22'W, 169; Cypress Hills (Breitung 1954).

Aster falcatus Lindl., Isley 53°18'N 110°33'W, 1822; Seven Persons 49°52'N 110°53'W, 581; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968).

Aster hesperius A. Gray, Dillberry Lake 52°35'N 110°01'W, 2049; Horseshoe Lake 52°21'N 110°44'W, 770; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968).

Aster junciformis Rydb., (U. of A. distr. map).

Aster laevis L. var *geyeri* A. Gray, Grant Creek 49°28'N 110°05'W, 1610; Kinsella 53°03'N 111°32'W, 1870; Big Knife 52°29'N 112°11'W, 1945; Cypress Hills (de Vries and Bird 1968).

Aster pansus (Blake) Cronq., Tulliby Lake 53°45'N 110°11'W, 879; Big Knife 52°29'N 112°11'W, 1897; Horseshoe Lake 52°21'N 110°44'W, 753; Kinsella 53°03'N 111°32'W, 1869; Acadia Valley 51°15'N 110°13'W, 2155; Seven Persons 49°52'N 110°53'W, 2190; Dillberry Lake 52°35'N 110°01'W, 2050; Pinhorn grazing res. 49°05'N 110°55'W, 2388.

Aster pauciflorus Nutt., Moss 1959.

Bidens cernua L., Ronalane 50°04'N 111°35'W, Moss 10652.

Bidens comosa (Gray) Wieg., (Moss 1959).

Bidens vulgata Greene, (Moss 1959).

Chrysopsis villosa (Pursh) Nutt., Dillberry Lake 52°35'N 110°01'W, 2097; Orion 49°25'N 110°50'W, 2318; Wildhorse 49°01'N 110°15'W, 2276; Seven Persons 49°52'N 110°53'W, 2226; Kinsella 53°03'N 111°32'W, 1308; Horseshoe Lake 52°21'N 110°44'W, 534; Empress 50°57'N 110°01'W, 1535; Dinosaur 50°45'N 111°34'W, 1216; HW 41 x Battle River 53°00'N 110°52'W, 251; Onefour 49°06'N 110°36'W, 1622; Wainwright 52°45'N 110°49'W, 331.

Chrysothamnus nauseosus (Pall.) Britt., Seven Persons 49°52'N 110°53'W, 2207; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968); Cypress Hills (Breitung 1954).

Cirsium flodmanii (Rydb.) Arthur, Altario 51°49'N 110°11'W, 2143; Orion 49°25'N 110°50'W, 2331; Pinhorn grazing res. 49°05'N 110°55'W, 2384; Wildhorse 49°01'N 110°15'W, 2269; Onefour 49°06'N 110°36'W, 1159; Schuler 50°22'N 110°18'W, 652; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968).

Cirsium undulatum (Nutt.) Spreng., (Moss 1959; de Vries 1968).

Coreopsis tinctoria Nutt., Wildhorse 49°01'N 110°15'W, 2274.

Crepis occidentalis Nutt., (Moss 1959; de Vries 1968).

Crepis runcinata (James) T. & G., (Moss 1959).

Erigeron caespitosus Nutt., Altario 51°49'N 110°11'W, 2170; Onefour 49°06'N 110°36'W, 2237; S. Sask. Riv. x HW 41 50°44'N 110°05'W, 2406; Seven Persons 49°52'N 110°53'W, 2192; Pinhorn grazing res. 49°05'N 110°55'W, 2386. Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968).

Erigeron canadensis L., Orion 49°25'N 110°50'W, 2344; Dillberry Lake 52°35'N 110°01'W, 2104; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968); Pendant d'Oreille 49°12'N 110°53'W, 2351.

Erigeron compositus Pursh, Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968); Cypress Hills (Breitung 1954).

Erigeron glabellus Nutt., Halkirk 52°23'N 112°00'W, 481; Horseshoe Lake 52°21'N 110°44'W, 539; Writing-on-Stone

49°07'N 111°39'W, (de Vries 1968); Cypress Hills (Breitung 1954).

Erigeron lonchophyllus Hook., Altario 51°49'N 110°11'W, 2144; Cypress Hills (Breitung 1954).

Erigeron philadelphicus L., Dillberry Lake 52°35'N 110°01'W, 2065; Cypress Hills (de Vries and Bird 1968).

Erigeron pumilus Nutt.,

Erigeron subtrinervis Rydb. var. *conspicuus* (Rydb.) Cronq., Cypress Hills (U. of A. distr. map).

Franseria acanthicarpa (Hook.) Coville, (Moss 1959).

Gaillardia aristata Pursh, Altario 51°49'N 110°11'W, 2116; Writing-on-Stone 49°07'N 111°39'W, 1662; Seven Persons 49°52'N 110°53'W, 586; Kinsella 53°03'N 111°32'W, 1304; Hand Hills 51°23'N 112°12'W, 567; Cypress Hills (Breitung 1954).

Gnaphalium palustre Nutt., Conrad 49°31'N 112°00'W, 2309.

Gnaphalium uliginosum L., Redcliff 50°05'N 110°47'W, Moss 9606.

Grindelia squarrosa (Pursh) Dunal Hand Hills 51°23'N 112°12'W, 1775; Provost 52°11'N 110°26'W, 344; Isley 53°18'N 110°33'W, 1832; Horseshoe Lake 52°21'N 110°44'W, 783; Seven Persons 49°52'N 110°53'W, 625; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968).

Gutierrezia sarothrae (Pursh) Britt. & Rusby, Altario 51°49'N 110°11'W, 2124 Isley 53°18'N 110°33'W, 1820; Seven Persons 49°52'N 110°53'W, 593; Big Knife 52°29'N 112°11'W, 1931; Chin Coulee 49°34'N 111°52'W, 1030; Dinosaur 50°45'N 111°34'W, 1737; Kinsella 53°03'N 111°32'W, 1853; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968).

Haplopappus lanceolatus (Hook.) T. & G., Acadia Valley 51°15'N 110°13'W, 2154; Pinhorn grazing res. 49°05'N 110°55'W, 2378; Altario 51°49'N 110°11'W, 2133; Onefour 49°06'N 110°36'W, 2240; Orion 49°25'N 110°50'W, 2232.

Haplopappus nuttallii T. & G., Seven Persons 49°52'N 110°53'W, 2194; Empress 50°57'N 110°01'W, 1536.

Haplopappus spinulosus (Pursh) DC., Provost 52°11'N 110°26'W, 346; Kinsella 53°03'N 111°32'W, 1841; Dinosaur 50°45'N 111°34'W, 1749; Isley 53°18'N 110°33'W, 1818; Seven Persons 49°52'N 110°53'W, 2213; Onefour 49°06'N 110°36'W, 2250; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968).

Helenium autumnale L., Acadia Valley 51?15'N 110?13'W, 2160.

Helianthus annuus L. ssp. *lenticularis* (Dougl.) Cockerell, (Moss 1959; de Vries 1968).

Helianthus laetiflorus Pers. var. *subrhomboideus* (Rydb.) Fern., Isley 53°18'N 110°33'W, 1825; Kinsella 53°03'N 111°32'W, 1789.

Helianthus maximiliani Schrad., (Moss 1959).

Helianthus nuttallii T. & G., Hand Hills 51°23'N 112°12'W, 1762; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968); Cypress Hills (Breitung 1954).

Helianthus petiolaris Nutt., Monitor, 2412; Onefour 49°06'N

110°36'W, 2243; Dillberry Lake 52°35'N 110°01'W, 2099; Dinosaur 50°45'N 111°34'W, 1748.

Hieracium albiflorum Hook., Cypress Hills (Breitung 1954).

Hieracium canadense Michx., Cypress Hills (Breitung 1954).

Hieracium cynoglossoides Arv.-Touv., Cypress Hills (de Vries and Bird 1968).

Hieracium umbellatum L., Horseshoe Lake 52°21'N 110°44'W, 755; Isley 53°18'N 110°33'W, 1829.

Hymenopappus filifolius Hook., (Moss 1959; de Vries 1968).

Hymenoxis acaulis (Pursh) Parker, Writing-on-Stone 49°07'N 111°39'W, 1055; Onefour 49°06'N 110°36'W, 1149.

Hymenoxis richardsonii (Hook.) Cockerell, Seven Persons 49°52'N 110°53'W, 2193; Grant Creek 49°28'N 110°05'W, 1591; S. Sask. Riv. x HW 41 50°44'N 110°05'W, 670; Kinsella 53°03'N 111°32'W, 1301; Dinosaur 50°45'N 111°34'W, 1731; Schuler 50°22'N 110°18'W, 661; Dinosaur 50°45'N 111°34'W, 1200; Empress 50°57'N 110°01'W, 1533; Onefour 49°06'N 110°36'W, 1131; Writing-on-Stone 49°07'N 111°39'W, 1712; Cypress Hills (Breitung 1954).

Iva axillaris Pursh, Pendant d'Oreille 49°12'N 110°53'W, 2356; Pinhorn grazing res. 49°05'N 110°55'W, 2377; Pendant d'Oreille 49°12'N 110°53'W; Onefour 49°06'N 110°36'W, 2246.

Iva xanthifolia Nutt., Pendant d'Oreille 49°12'N 110°53'W, 2353.

Lactuca pulchella (Pursh) DC., Monitor, 2413; Orion 49°25'N 110°50'W, 2341; Schuler 50°22'N 110°18'W, 646; Kinsella 53°03'N 111°32'W, 1855; Horseshoe Lake 52°21'N 110°44'W, 762; Walsh 50°07'N 110°04'W, 1560; Clandonald 53°35'N 110°45'W, 742; Hand Hills 51°23'N 112°12'W, 1772; Writing-on-Stone 49°07'N 111°39'W, 1711; Cypress Hills (de Vries and Bird 1968).

Liatris ligulistylis (A. Nels.) K. Schum., Tulliby Lake 53°45'N 110°11'W, 855; Clandonald 53°35'N 110°45'W, 743; Horseshoe Lake 52°21'N 110°44'W, 816.

Liatris punctata Hook., Pendant d'Oreille 49°12'N 110°53'W, 2360; Wildhorse 49°01'N 110°15'W, 2268; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968); Cypress Hills (Breitung 1954).

Lygodesmia juncea (Pursh) D. Don, Pinhorn grazing res. 49°05'N 110°55'W, 2381; Big Knife 52°29'N 112°11'W, 1939; Provost 52°11'N 110°26'W, 341; Kinsella 53°03'N 111°32'W, 1848; S. Sask. Riv. x HW 41 50°44'N 110°05'W, 669; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968).

Lygodesmia rostrata A. Gray, Orion 49°25'N 110°50'W, 2317; Dillberry Lake 52°35'N 110°01'W, 2096.

Madia glomerata Hook., (Breitung 1954; Moss 1959).

Petasites palmatus (Ait.) A. Gray, Lea Park 53°39'N 110°22'W, 7.

Petasites sagittatus (Pursh) A. Gray, Dillberry Lake 52°35'N 110°01'W, 1477; Cypress Hills (de Vries and Bird 1968).

Petasites vitifolius Greene, Cypress Hills (Breitung 1954).

Psilocarpus eliator A. Gray, (Moss 1959).
Ratibida columnifera (Nutt.) Wooton & Standl., Pinhorn grazing res. 49°05'N 110°55'W, 2397; Monitor, 2407; Dinosaur 50°45'N 111°34'W, 1742; Seven Persons 49°52'N 110°53'W, 600; Onefour 49°06'N 110°36'W, 1619; Alliance 52°40'N 111°05'W, 1783; Writing-on-Stone 49°07'N 111°39'W, 1661.
Ratibida columnifera (Nutt.) Wooton & Standl. forma *pulcherrima* (DC.) Fern., S. Sask. Riv. x HW 41 50°44'N 110°05'W, 672.
Senecio canus Hook., Seven Persons 49°52'N 110°53'W, 2220; Pinhorn grazing res. 49°05'N 110°55'W, 2387; Writing-on-Stone 49°07'N 111°39'W, 1113; Edgerton 52°45'N 110°28'W, 111; Hand Hills 51°23'N 112°12'W, 566.
Senecio congestus (R. Br.) DC. var. *palustris* (L.) Fern., Kinsella 53°03'N 111°32'W, 1285; Edgerton 52°45'N 110°28'W, 116; Seven Persons 49°52'N 110°53'W, 1173.
Senecio eremophilus Richards., Kinsella 53°03'N 111°32'W, 1871; Laurier Lake 53°50'N 110°34'W, 1388.
Senecio hydrophiloides Rydb., Grant Creek 49°28'N 110°05'W, 1603; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968).
Senecio indecorus Greene. Cypress Hills (Breitung 1954).
Senecio integerrimus Nutt. var. *exaltatus* (Nutt.) Cronq., (U. of A. distr. map).
Senecio pauperculus Michx., Altario 51°49'N 110°11'W, 2132; Kinsella 53°03'N 111°32'W, 1352.
Senecio pauperculus Michx., Cypress Hills (de Vries and Bird 1968).
Senecio pseudaureus Rydb., (Cypress Hills (U. of A. distr. map).
Solidago decumbens Greene, Tulliby Lake 53°45'N 110°11'W, 872; Big Knife 52°29'N 112°11'W, 1904; Wainwright 52°45'N 110°49'W, 393; Kinsella 53°03'N 111°32'W, 1854; Horseshoe Lake 52°21'N 110°44'W, 761; Lea Park 53°39'N 110°22'W, 837; Cypress Hills (Breitung 1954).
Solidago gigantea Ait. var. *leiophylla* Fern., Dinosaur 50°45'N 111°34'W, 1728; Altario 51°49'N 110°11'W, 2180; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968).
Solidago graminifolia (L.) Salisb., Horseshoe Lake 52°21'N 110°44'W, 769.
Solidago lepida DC., Big Knife 52°29'N 112°11'W, 1902; Kinsella 53°03'N 111°32'W, 1834; Hand Hills 51°23'N 112°12'W, 1774.
Solidago missouriensis Nutt., Wainwright 52°45'N 110°49'W, 393; Dillberry Lake 52°35'N 110°01'W, 1436; Isley 53°18'N 110°33'W, 1830; Grant Creek 49°28'N 110°05'W, 1584; Kinsella 53°03'N 111°32'W, 1837; Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968); Cypress Hills (Breitung 1954).
Solidago mollis Bartl., (Moss 1959).
Solidago nemoralis Ait. var. *decemflora* (DC.) Fern., Horseshoe Lake 52°21'N 110°44'W, 443; Seven Persons

49°52'N 110°53'W, 663; Wainwright 52°45'N 110°49'W, 391.

Solidago pruinosa Greene, (Moss 1959).

Solidago rigida L. var. humilis Porter, Pinhorn grazing res. 49°05'N 110°55'W, 2385; Kinsella 53°03'N 111°32'W, 1838; Lea Park 53°39'N 110°22'W, 854; HW 41 x Battle River 53°00'N 110°52'W, 235; Cypress Hills (Breitung 1954).

Townsendia hookeri Beaman, (U. of A. distr. map).

Townsendia parryi D. C. Eat., (U. of A. distr. map).

Townsendia sericea Hook., Writing-on-Stone 49°07'N 111°39'W, (de Vries 1968); Cypress Hills (Breitung 1954).

Xanthium strumarium L., Orion 49°25'N 110°50'W, 2349; Cypress Hills (Breitung 1954).